REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
AUGUST 1995

3. REPORT TYPE AND DATES COVERED
FINAL REPORT 07-94 TO 07-95

4. TITLE AND SUBTITLE
Neonatal Intensive Care Unit Cost Avoidance in the Colorado Springs Catchment Area.

5. FUNDING NUMBERS

6. AUTHOR(S)
MAJOR RICHARD S. ELLENBERGER, Medical Service Corps

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Commander, ATTN: MCXE-DCAS
USA MEDDAC (Evans Army Community Hospital)
BLDG 7500
FORT CARSON, CO 80913-5101

8. PERFORMING ORGANIZATION REPORT NUMBER
13a-95

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
BLDG 2841 HSHA MH US ARMY-BAYLOR UNIVERSITY GRAD PGM IN HCA
3151 SCOTT ROAD
FORT SAM HOUSTON TEXAS 78234-6135

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)
Due to increased utilization of neonatal intensive care services in the Colorado Springs catchment, the elimination of Fitzsimons Army Medical Center's neonatal intensive care unit (NICU), a monopoly market for NICU services in Colorado Springs, and high altitude effects on pregnancy encountered in Colorado, local CHAMPUS expenditures for NICU services exceeded $2 million in 1994. The purpose of this research was to determine if Evans Army Community Hospital should enter the market for Level II NICU services in Colorado Springs. A make or buy project evaluation was conducted by discounted cash flow analysis over a 6 year term. Profitability measures were adjusted for capital risk using 256 spreadsheet simulations to conduct a sensitivity analysis for optimum, minimum, and most likely case scenarios. A subjective consideration of the project's social value was accomplished by Delphi panel using a qualitative analysis of both options. The project's expected net present value under the most likely case was $5,348, with a 0.48 probability of break even cash flow. The qualitative analysis favored the make option. Based on marginal
(Continued on Reverse)

14. SUBJECT TERMS
Neonatal Intensive Care Unit, CHAMPUS cost avoidance
Capital Budgeting analysis, Spreadsheet risk simulation

15. NUMBER OF PAGES
141

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
N/A	N/A	N/A	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)

U. S. ARMY - BAYLOR UNIVERSITY

GRADUATE PROGRAM IN HEALTH CARE ADMINISTRATION

GRADUATE MANAGEMENT PROJECT:

Level II Neonatal Intensive Care Unit Cost Avoidance in the Colorado Springs Catchment Area

SUBMITTED TO

LIEUTENANT COLONEL RICHARD L. HOLMES, MS

IN CANDIDACY FOR THE DEGREE OF

MASTER OF HEALTH CARE ADMINISTRATION

BY

MAJOR RICHARD S. ELLENBERGER, MS, CHE

FORT CARSON, COLORADO

JULY 1995

ABSTRACT

Due to increased utilization of neonatal intensive care services in the Colorado Springs catchment, the elimination of Fitzsimons Army Medical Center's neonatal intensive care unit (NICU), a monopoly market for NICU services in Colorado Springs, and the high altitude effects on pregnancy encountered in Colorado, local CHAMPUS expenditures for NICU services exceeded $2 million in 1994. The purpose of this research was to determine if Evans Army Community Hospital should enter the market for Level II NICU services in Colorado Springs. A make or buy project evaluation was conducted by discounted cash flow analysis over a six year term. Profitability measures were adjusted for capital risk using 256 spreadsheet simulations to conduct a sensitivity analysis for optimum, minimum, and most likely scenarios. A subjective consideration of the project's social value was accomplished by Delphi panel using a qualitative analysis of both options. The project's expected net present value under the most likely case was $5,348, with a 0.48 probability of break even cash flow. The qualitative analysis favored the make option. Based on marginal profitability of the cash flow analysis, demographic changes at Fort Carson in force structure, budget constraints, health services manpower reductions, and business strategy preparatory to TRICARE the project was not recommended for implementation.

ACKNOWLEDGEMENT

I wish to express my gratitude to the following health care professionals at Evans Army Community Hospital:

1) Physician Executives: Colonel Ron Jones
   Lieutenant Colonel Joe Dai
   Lieutenant Colonel Randy Jones

2) Nurse Executives: Colonel Jane Yaws
   Lieutenant Colonel Pat Cefaly
   Lieutenant Colonel Tami Kephardt

3) Managed Care: Dr. Art Badgett
   Ms. Denise Downs

4) Medical Library: Ms. Roma Marcum

for their patience, assistance, opinions, and guidance throughout the conduct of this study. My deepest appreciation to my mentor and preceptor, Colonel Ken Leisher, who allowed me the freedom to apply theory, learn from experience, and openly express my ideas and opinions. Most importantly a sincere debt of gratitude to my wife, Sheri, and son, Brian, whose understanding, support, and patience encouraged my academic endeavor for the past 2 years.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

A. Conditions Which Prompted the Study

In early August, 1994, Fitzsimons Army Medical Center (FAMC), located in Denver, Colorado, announced the closing of their Neonatal Intensive Care Unit (NICU) and obstetric service, effectively eliminating all residency training programs in neonatology, perinatology, and obstetrics for assigned staff. By October 1, 1994, FAMC was no longer admitting neonates and referring all newborns requiring neonatal intensive care to Denver Children's Hospital by Non-availability Statement (NAS).

Evans Army Community Hospital (EACH), located at Fort Carson in southeastern Colorado Springs, currently operates an obstetric service on Ward 3 East which contains five labor and delivery rooms, one dedicated operating room for obstetric cases, a newborn nursery with 36 bassinets, and a 35 bed post-partum ward (S. Jones 1994). Although EACH's newborn nursery is a Level I facility for neonatal care, as classified by the American Board of Obstetrics and Gynecology's standards for Perinatal Care (ABOG 1993) and the Joint Commission on Accreditation of Health Care Organization's (JCAHO) 1995 standards (JCAHO 1994), the nursery has a modified Level II capability to admit Level II 'step down' neonates, who are in a feed and grow status and require limited

ventilator support. Neonates who require more intensive medical management, surgical procedures, and life support measures, are typically referred to Memorial Hospital's NICU in downtown Colorado Springs or to the FAMC NICU.

The U.S. Air Force Academy (USAFA) hospital, located in the northwestern corner of the Colorado Springs city limits and twenty-three miles from Fort Carson, operates an obstetric service with four labor and delivery rooms, non-dedicated operating room availability, a nursery with 25 bassinets, and ten post-partum beds (Svetz 1994). USAFA hospital's nursery is a Level I neonatal care facility (routine nursery) by JCAHO and ABOG standards. Neonates, whose medical condition warrants admission to more definitive care than otherwise available in a routine nursery, are referred to Memorial Hospital in downtown Colorado Springs after coordination with the Patient Support Division at EACH, which serves as the CHAMPUS lead agent in the Pike's Peak Region.

Located on the northeast side of Denver in the suburb of Aurora, FAMC is 75 statute miles via Interstate 25 and 62 nautical miles via direct flight routing from Fort Carson. Due to the amount of travel time during evacuation by ground or air ambulances, few neonates from the Colorado Springs catchment, who required Level II or III neonatal intensive care, were

historically transported or admitted to the NICU at Fitzsimons or nearby Denver Children's Hospital.

As a result of these transport distances and the inherent risk of neonate management during transport, almost 93% of NICU admissions for the Colorado Springs catchment area are referred to Memorial Hospital in downtown Colorado Springs (Cefaly 1994). Although there are several public and private hospitals in the Colorado Springs metropolitan area (Memorial, Penrose, Humana, and Saint Francis), Memorial Hospital operates the only full service NICU, certified to Level III.

The Colorado Springs catchment area includes 134,000 Department of Defense beneficiaries from the Army, Navy, and Air Force serving at Fort Carson, USAFA, North American Radar Air Defense Command (NORAD), Peterson Air Force Base and Falcon Air Station (DMIS 1994). Active duty, their dependents, and other eligible beneficiaries receive obstetric in-patient care through EACH and USAFA hospitals or receive standard CHAMPUS with a Non-availability Statement (NAS). The Catchment Area Management (CAM) demonstration project, which concluded in 1991, greatly affected the market for obstetric services in downtown Colorado Springs. The Military Health Service System's (MHSS) demonstration project permitted the local Military Treatment Facilities (MTFs) to hire partnership providers in obstetrics and greatly decreased the NAS issued for obstetric care. The impact of the CAM was a dramatic reduction in demand for obstetric services in the civilian market

sector. As a result of the change in market demand created by the recapture of military obstetric cases via the CAM and intense market competition form Memorial Hospital, Saint Francis hospital was forced to close their obstetric inpatient services (Badgett 1994a).

With the equilibration of the market for obstetric and NICU services, the MHSS in the Colorado Springs catchment area is subject to a monopoly market for NICU services. Further exacerbated by the October, 1994, closure and nonavailability of the Fitzsimons NICU, EACH and USAFA hospital are now situational price-takers for Memorial's NICU services. EACH attempted to negotiate a 25% discount off of CHAMPUS allowable charges with Memorial Hospital for NICU services during August 1994; however, memory of the CAM demonstration, the increased demand in the civilian market segment due to population growth, and lack of bargaining power are speculation for Memorial's refusal to negotiate (R. Jones 1994).

Memorial's fee schedule lists the average charge per day on the Level III NICU at $8300, which includes professional fees, ancillary services, and hospital charges. The Level II average charge to private pay patients is $7450 per day (Cefaly 1994).

During the past winter, the Fort Carson installation was surveyed by the Base Realignment and Closure (BRAC) committee as a target for base closure. Although the installation was not ultimately recommended for closure by the committee, force

realignment decisions were announced by the Department of the Army which will reduce the active duty population assigned to Fort Carson by 2700 soldiers (Downs 1994). The 4th Infantry Division headquarters, the Division Support Command, the Aviation Brigade, and the 3rd Brigade were eliminated, although the division's flag survived and will relocate to Fort Hood. The 10th Special Forces Group is relocating to Fort Carson due to the congressionally approved base closure of Fort Devens, Massachusetts. The 3rd Armored Cavalry Regiment, previously assigned to Fort Bliss, Texas, will also relocate to Fort Carson over the summer. Even though the population of the Fort Carson catchment is projected to decrease by a net change of approximately 8100 active duty and their dependents, the force restructuring has important impact on the demographic attributes of the post population with regard to health services. Due to the younger age and rank of these two new cohorts of soldiers and dependent family members relative to the age and rank of those soldiers assigned to the Division Headquarters, Installation and Brigade staffs, the number of women and female dependents of child-bearing age in the catchment may increase the birth rate experienced in the catchment by comparison.

The crude birth rate in the Colorado Springs catchment area, which includes births at EACH and USAFA MTFs, has increased steadily from Fiscal Year (FY) 1992 through 1994. In FY '92 the average was 135 births per month between both MTFs. By the end of FY '94 that average had increased 33 percent to 179 births per

month (DMIS 1994). The USAFA hospital reported 57 births for September 1994, while EACH experienced a record 177 births during the same month for a combined monthly total of 234 (Cefaly 1994). With the additional influx of four battalions of Special Forces troops and an entire cavalry regiment over the next twelve months, the average birth rate is expected to increase to 190 births per month with peak totals of 240 per month possible in the aftermath of unit deployments to Guantanomo Bay and Haiti by 4th Infantry Division (Mech) soldiers during the last quarter of FY 1994.

Concordant with the 33 percent increase in crude birth rate experienced in the Colorado Springs catchment area, the number of NICU referral admissions to Memorial Hospital has also increased over the past two years. The Denver catchment area, now lacking the services of the FAMC NICU, has also increased its referrals to the Denver Children's Hospital NICU.

In FY '92 the Colorado Springs catchment area referred 38 cases to Memorial NICU. Memorial billed the Federal government $2,323,000, and the Government paid $982,000 for 819 NICU bed days. In FY '93, the catchment experience was 98 cases to Memorial NICU with a billing of $3,911,000 and payment by the government of $2,360,000 for 1546 bed days (Cefaly 1994).

Two additional factors bear on the market for NICU services in the Colorado Springs catchment area. The first is the clinical effect of altitude and reduced partial pressure of oxygen (hypobaric hypoxia) on term pregnancy and delivery

outcome unique to the 6300 feet Mean Sea Level elevation encountered in the Colorado Springs catchment area. Empirical evidence, further developed in the Literature Review section of this introduction, suggests a strong functional relation between high altitude pregnancy and perinatal complications, which may function as a clinical artifact to increase the incidence of NICU admissions in Colorado. The second factor concerns the impact of Tricare implementation in Region 8 (Mantia 1994, Badgett 1994a).

The Region 8 Request For Proposal (RFP) was released from FAMC in early May 1995 for contractor consideration and bids. Due to the provision and nuances of Managed Care Contractor bid price adjustments (Montgomery 1994), Brigadier General J. Sutherland Parker, Commanding General of FAMC and the Region 8 Lead Agent, requested that EACH conduct a preliminary feasibility assessment of operating a Level II NICU at Fort Carson as early as August 1994 in order to recapture the high cost of these services. Without the FAMC NICU, Region 8 lacks a military referral center for perinatology services.

The Level II NICU feasibility assessment revealed a recapture possibility for 88 cases in the Colorado Springs catchment areas (USAFA, Peterson and EACH) with an estimated CHAMPUS cost savings of $552.3 K. Adding the FAMC catchment's recapture of 185 cases to the Colorado Springs 88 cases yielded a projection of 273 Level II cases for an estimated CHAMPUS recapture of $1.07 M. The estimated startup cost for the

required incremental staffing to recapture the Colorado Springs and Denver Level II neonates was $568 K, which did not include the costs of biomedical equipment or renovation of the existing nursery (Badgett 1994b). The preliminary analysis recommended against recapture of Level II neonates beyond the Colorado Springs catchment due to existing CHAMPUS rules and the added cost of neonatal transport and guest housing at Fort Carson. Fortunately, the serviceable biomedical equipment available to upgrade the EACH nursery to Level II was identified and transferred to EACH from FAMC by logistics following the FAMC NICU closure in October 1994. An initial strategy to transfer military personnel authorizations from FAMC to EACH in nursing and pediatric specialties was also recommended at this time to avoid the anticipated high cost of contracting for these specialties in the Colorado Springs market. The availability of relevant professional staffing and NICU biomedical equipment without incremental cost to the proposed Level II NICU at EACH made this an attractive business strategy.

In October, 1994, General Parker expanded the study's focus to a full Level III NICU with EACH serving as the Region 8 referral center to replace the lost capabilities at FAMC. In December, 1994, Colonel Homer J. Wright, the commanding officer of the hospital and the Pike's Peak region lead agent, briefed General Parker that a Level III NICU was untenable in Colorado Springs due to the questionable ability to attract and sustain

the tertiary care providers from the local market in perinatology, pediatric cardiology, neurology, pulmonology, and genetics required for a Level III NICU. Other project constraints were resource allocation and funding requirements for enhanced ancillary support services, biomedical equipment, and renovation costs associated with the Level III NICU. A rudimentary cash flow analysis revealed a projected CHAMPUS savings of $5.1 million if the Colorado Springs and Denver catchment's NICU workload of 433 cases were recaptured in the proposed Level III NICU at EACH. The Level III NICU at EACH had an estimated start up cost of $5.5 million and annual recurring costs of $3.7 million (Badgett 1994c). The bottom line answer to General Parker was that the Level III initiative was not financially feasible without military specialty providers, medical equipment, and start up capital resources provided by the Region 8 lead agent.

Following these initial studies of Level II and Level III NICU recapture, General Parker decided that EACH would not become a regional referral center for any patient services and that transfer of military pediatric provider authorizations and personnel from FAMC to EACH was not possible due to projected reductions in physician and nurse corps end strength. Subsequent to this decision, FAMC was recommended for closure to the congressional BRAC by the Secretary of the Army, Togo West. These events, further amplified by a reduction in the Army Medical Department end strength and decreased apportionment of

providers to EACH for FY 1996 by the Office of the Surgeon General, eliminated any speculation that EACH would evolve to a mini-Medical Center without Graduate Medical Education. Should FAMC's recommended closure become law, Region 8 would lack a tertiary military facility and, by design, the Tricare contractor would absorb these services as required by the RFP. These signals combined with a low risk bid price adjustment strategy preempting the introduction of any new services which could not be sustained throughout the baseline period for Tricare, removed all remaining impetus for further NICU feasibility assessments in Colorado Springs.

Managed care initiatives at the local level between USAFA Hospital and EACH have created preliminary strategy to integrate services between the Air Force and Army MTFs to enhance productivity and gain efficiency preparatory to Tricare. The Air Force commander is reluctant to totally discontinue obstetric services at USAFA hospital for consolidation at EACH due to command concerns over discretion in cadet pregnancies and Air Force beneficiary dissatisfaction with having to travel 25 miles to Fort Carson for prenatal care and delivery (R. Jones 1994).

In summary, economic, environmental, clinical, and political factors have prompted the situational conditions for this graduate management project to study neonatal intensive care services and cost avoidance in the Colorado Springs catchment area. The initial quantitative analysis for the limited Level II

NICU project was favorable, especially given the transfer of high cost biomedical equipment from the FAMC NICU. However, these preliminary analyses lacked the financial management refinements of discounted cash flow analysis and relevant incremental costs (Gapenski 1993, Berman et. al. 1993). The NICU issue is a high volume, high cost product line which has substantial impact on health care service delivery to MHSS beneficiaries in Colorado Springs. The risk factors for preterm delivery associated with a transitory military population, augmented by two large cohorts of young soldiers, altitude effects on pregnancy outcome unique to this region, nonavailability of a military referral center for NICU services in Region 8, and the strategic management necessary to minimize the impact of Tricare contract bid price adjustment, present a unique combination of demographic, clinical, and administrative factors which piqued this author's and several levels of Medical Command interest in NICU cost avoidance in the Colorado Springs catchment area.

B. Statement of the Problem

Due to the increased volume and demand for NICU services experienced over the past 24 months, the monopsony power of Memorial Hospital in the local NICU market, the non-availability of the FAMC NICU, and the clinical interaction of demography, medical history, and high altitude exogenous factors unique to this area of the MHSS, CHAMPUS expenditures for NICU services

have reached significant levels. The problem issue requires a Make / Buy project evaluation (Levin et. al. 1993) via a capital budgeting cash flow analysis (Gapenski 1993) to determine if the CHAMPUS cost avoidance would generate adequate recapture to make the capital cost of building a limited Level II NICU at EACH financially feasible. The availability of FAMC's NICU equipment, already inspected, accepted for transfer to the property book and, in some cases, already in use in the EACH nursery, dramatically reduces the start up incremental cost of creating a Level II NICU within the existing physical plant at EACH. Those caveats from the original Level II feasibility analysis for a Level II NICU without surgery nor admission when the gestational age of the fetus is less than 32 weeks and/or birth weight less than 1500 grams will remain as project constraints (Badgett 1994b).

C. Literature Review

The effects of altitude on human pregnancy are well documented in both the anthropologic and clinical literature of the obstetric, pediatric, perinatology, and neonatology disciplines. The body of available literature on prematurity prevention and risk assessment methodologies during the prenatal period are equally abundant. Far less prevalent are extant operational cost studies and financial management analyses of hospital NICU operations. However, the health care economic

literature does contain several studies which justify the tremendous cost of providing NICU services in terms of the social value gained by those neonates who survived fetal demise due to the availability of a NICU.

This literature review will develop each of these NICU subject areas in the following sequence: Altitude Effects on Preterm Delivery, Prediction and Prevention of Preterm Events, and NICU Economic Studies. The Summary section will integrate and synthesize the relevant points from each of these three areas with regard to the problem under consideration.

1) Altitude Effects on Preterm Delivery

A review of the clinical literature for the effects of altitude on pregnancy outcomes reveals abundant, current research in the intermontane regions of Tibet (Zamudio et. al. 1993a), Bolivia (Mayhew 1991), Saudi Arabia (Mahfouz et.al. 1994), India (Neela and Raman 1993), Peru (De Meer et.al. 1993), and in particular, the state of Colorado (Yancey and Richards 1994, Zamudio et. al. 1993b, Yancey et. al. 1992, Moore et. al. 1992, Moore and Cayle 1990, Unger et. al. 1988), with respect to the differential effects of hypobaric hypoxia on perinatology and delivery outcomes at high and low elevations.

High altitude pregnancy poses greater clinical risk for both mother and infant due to predisposition of maternal hypertension, pre-eclampsia, eclampsia (Moore et al. 1992), intrauterine growth

retardation, (Zamudio et. al. 1993a), lower fetal birth weight (Zamudio et. al. 1993b), increased amniotic fluid volume (Yancey and Richards 1994), impaired utero-placental perfusion, blood oxygen diffusion (Mayhew 1991), and restricted nutrient delivery across the placenta (Yancey et. al. 1992). Unger et al. (1988) retrospectively identified a 46% decrease in infant mortality in Colorado pregnancies due to increased availability and transport to tertiary neonatal treatment centers (NICU) from 1968 through 1988.

During deliveries at altitude, increased incidence of maternal hyperventilation increases fetal blood pH, which triggers fetal tachycardia and anoxia (Yancey et. al. 1992). Maternal physiologic compensation mechanisms for reduced oxygen tension at altitude are increased maternal red blood cell mass (hematocrit) and plasma volume; however, fetal physiologic compensation is unremarkable (Mayhew 1991). Further, women who relocate from low altitude to high altitude during the third trimester of their pregnancies experience significantly greater fetal distress during delivery, particularly if the birth weight is greater than 3000 grams or 6.6 pounds (Zamudio 1993b). This artifact should manifest itself among the 10th Special Forces Group and 3rd Armored Cavalry Regiment beneficiaries who deliver within three months of arrival at Fort Carson from the relatively low altitude environs of Fort Devens and Fort Bliss.

In opposition to these prominent researchers, who have found significant interactions between altitude and its effect on term pregnancy and delivery outcome, a recent study conducted at Memorial Hospital in Colorado Springs presents a dissenting opinion with the majority of research on the effects of altitude on pregnancy and delivery outcome (El-Bastawissi 1994).

In her retrospective, matched control study of 793 subjects, 333 women from Colorado Springs, who experienced preterm labor, were compared with 460 control subjects without preterm labor. Patient interview and medical record review data were analyzed along seven risk groups by logistic regression, Mantel-Haensel odds ratios, and summary measures of association to control for confounding factors (Fleiss 1981). One of the seven risk groups studied was altitude effects to include altitude changes due to travel, altitude at conception, altitude of previous pregnancies, altitude of previous preterm delivery, interaction of altitude with smoking, and the interaction of altitude with hematocrit value. Of all the independent altitude variables studied, none were statistically significant at an alpha level of .05 and beta set at .10. Additionally, no confounding interactions of altitude with smoking or altitude with hematocrit value were observed.

The author chose an altitude change of greater than 2500 feet anytime during pregnancy as the criterion for binary coding because practitioners consider such a change during pregnancy as

clinically significant. Colorado Springs residents frequently make altitude changes of over 2500 feet during travel to nearby cities, parks, and lakes west of Colorado Springs. A popular sight seeing trip for residents of Colorado Springs is a steep ride to the summit of Pikes Peak by rack rail train which involves a net altitude change of over 8000 feet!

In rebuttal to the El-Bastawissi findings regarding altitude, the lack of any altitude effects or confounding interaction of altitude in this study are most likely an artifact of the precision with which measurement of altitude change occurred, e.g. measurement error. Altitude change was determined by showing the patient a large scale, color-coded, topographic map with a 500 feet contour interval and inspection of the map with the aid of a magnifying glass. At any color-coded boundary on the map, a self-report error of 500 to 1000 feet is possible. Further, altitude effects may have been minimized in the experimental group due to rigorous exclusion criteria for subjects based on medical history. Although this screening method was equally applied to both the control and experimental group for chronic disease, hypertensive disorders, and maternal trauma during pregnancy, it may act to limit the study's experimental variance and artificially preclude confounding of altitude interactions. Finally, as the author contends in her discussion, altitude studies are best conducted through multi-centered studies using low, medium, and high altitude populations for

comparison. It is significant that this methodology was used in all the cited altitude studies where researchers discovered a significant altitude effect on pregnancy.

In addition to altitude, it is noteworthy that other environmental effects such as temperature, humidity, barometric pressure and circadian light/ dark cycles influenced the incidence of pre-eclampsia in high altitude pregnancy in a large Saudi Arabian study of over 7000 subjects (Mahfouz et. al. 1994).

2) Prediction and Prevention of Preterm Events

The impact of exogenous factors, previous medical history, and maternal demographics on preterm events have lead several researchers to develop prospective risk assessment scoring systems through multivariate studies of clinically validated risk factors (El-Bastawissi 1994, Heffner et. al 1993, Creasy and Resnick 1989). These prospective assessments, complimented by patient-tailored, prenatal care have significantly reduced the incidence of preterm events and neonate morbidity. Prematurity prevention and prenatal care appropriate to the risks encountered have increased fetal birthweight by 250 to 300 grams and prolonged gestation by as much as 14 days (Klaus and Fanaroff 1994).

Life style choices such as tobacco, alcohol, and drug use are known to affect delivery outcome. Predisposing medical history and pre-existing medical conditions such as hypertensive

history, obesity, lupus, diabetes, multiple birth, and short inter-pregnancy interval are all risk factors which increase the incidence of premature delivery (Dai 1994, El-Bastawissi 1994, Eskenazi et. al. 1991, WHO 1988).

Maternal demography such as stature under 61 inches, pre-pregnancy weight less than 110 pounds, parity (high multipara or nulliparous), single marital status, less than 12 years of education, and maternal age under 18 years or over 35 years are frequently used as benchmarks in prospective risk assessments for preterm events (El-Bastawissi 1994, Creasy and Resnick 1989, Holbrook et. al. 1989, Ernest et. al. 1988.)

The two most popular risk scoring systems, Creasy's and Holbrook's, require extensive input of over 40 variables and prospectively predict the onset of preterm labor in the range of 20 to 37 weeks gestation. The Creasy model has a sensitivity of 44%, a false negative rate of 56%, and was developed using New Zealanders in 1980. The Holbrook model has a sensitivity of 42%, a false negative rate of 58%, and was developed using Californians in 1989. Holbrook's model is a modification of Creasy's using Chi square statistical analysis. Neither model controlled for confounding interaction of independent variables. The El-Bastawissi study (1994) produced a retrospectively developed predictor equation using multiple logistic regression of 11 variables. Some benefits of the El-Bastawissi model are its higher sensitivity (71%), reduced false negatives (29%)

control for confounding variable interaction, independence from laboratory test results and use of Colorado Springs subjects.

Prevention of preterm labor and delivery is accomplished through both medical and surgical treatment means. Hypertensive medications for pre-eclampsia, cerclage for incompetent cervix and tocolytic agents for premature labor are some examples of these interventions to delay the delivery as long as possible while safeguarding the fetus (Dai, 1994, S. Jones 1994). However, the capability to provide timely intervention is critically dependent on the early identification, longitudinal tracking, and continuity of prenatal care providers for those women at risk for premature labor and delivery.

At the present time, EACH obstetric services conducts a preliminary preterm risk evaluation during the first prenatal visit. However, the assessment includes only nine questions, is not modelled after any published or empirically validated risk assessment methodology, and is subjectively evaluated by an obstetrician as one of two levels of risk: routine pregnancy or complicated pregnancy. If the assessment is routine pregnancy, the mother receives her prenatal care through her family practitioner in the primary care clinic. If the assessment is complicated pregnancy, the mother receives her prenatal care through an obstetrician in the specialty (OB/GYN) clinic.

The expectant mother with a complicated pregnancy risk assessment receives prenatal care visits with double the

frequency (every 2 weeks compared to every 4 weeks) as compared to the routine pregnancy (S. Jones 1994). She also receives patient education in preterm labor prevention, identification of preterm labor symptoms, and emergency actions which has proven to reduce the probability of a preterm delivery (Andersen et. al. 1989).

In the words of Poor Richard Saunders, "an ounce of prevention is worth a pound of cure." The prospective assessment and antepartum management of mothers at high risk for premature delivery is a highly cost efficient means to improve delivery outcome and minimize NICU utilization. The use of empirically validated assessments and medical protocols to prevent premature delivery, i.e. a prematurity prevention program, is a definitive means for EACH to reduce CHAMPUS expenditures for NICU services in Colorado Springs.

3) NICU Economic Studies

The health administration and health care economic literature review yielded very few relevant articles on incremental costing and capital budgeting studies of hospital NICU operations. The available literature did reveal that NICU operating costs are among the highest in tertiary care medical centers (Connolly et. al. 1989), and that NICUs are extremely resource intensive, especially for biomedical equipment (Fenton and Field 1990), nursing staff, and ancillary services (Lobas et. al. 1991). Imershein et. al. (1992) demonstrated that NICU care

is subject to frequent cost shifting from high volume, indigent patents covered by Medicare to private pay or third party insured patients in the state of Florida's hospital system offering NICU services. The federal agency allowed reimbursement rate for DRG 386 (extreme prematurity with respiratory distress) was $13,900 while Florida hospitals median charges for treatment with a DRG 386 diagnosis was actually $32,900 (Imershein et. al. 1992, 57).

In their 1989 study of the cost components of neonatal intensive care services in Dublin, Ireland, Connolly et. al. (1989) reported the proportional cost components for the NICU as: Nursing Staff, 51%; Medical Staff, 11%; Consumable Medical Supplies, 18%; Ancillary Services, 12%, and Other, 8%.

Other researchers have developed neonate risk assessment methodologies (British Neonatal Network 1993, Subramanian et. al. 1989) and mathematical nomograms (Pearlman et. al. 1992) used to forecast length and acuity of hospital stay based on initial status. Psychologists have suggested specialized developmental care for preterm neonates on the unit to increase stimulation of the perceptual senses and human contact which have proven effective in the reduction of the length of stay (Als et. al. 1994). This body of research attempts to alleviate and estimate the long term cost of pediatric care for a premature infant during the first year of life.

Boyle et. al. (1983) retrospectively evaluated the economic cost of providing NICU care to very low birth weight i

infants before and after the introduction of a NICU in Ontario, Canada. Their analysis found that for infants weighing 1000 to 1499 grams the cost in 1978 Canadian dollars was $59,500 per survivor and $3,200 per quality adjusted life year gained. The cost for infants weighing 500 to 999 grams were $102,500 per survivor and $22,400 per quality adjusted life year gained. All costs were discounted by a rate of 5% per annum over a term of 3 years post partum. The Boyle study concluded that the combined cost of NICU care and three years' post partum care resulted in net economic loss when discounted, but NICU availability doubled survival rates. In the Mc Cormick et. al. (1991) research, the post-hospitalization costs of 32 very low birth weight (VLBW < 1500 grams) infants were compared to 32 term infants discharged from Children's Hospital in Philadelphia. The quarterly costs were VLBW infants $10,139 and term infants $1179 in 1990 dollars. This cost differential was greatest for the first quarter and minimal after the fourth quarter. A third study of post partum pediatric costs in Detroit (Shankaran e.t. al. 1988) revealed that children with persistent neurologic deficits following NICU discharge compared to birth weight matched controls without neurologic deficits have triple the long term care costs in the first year post partum.

As a cost saving strategy to reduce charges for NICU length of stay, Phibbs et. al. (1992) suggest "back transport" of NICU neonates from tertiary care facilities to local community

hospitals as a cost avoidance measure which pays for the cost of air evacuation and can save $5000 over a 7 day length of stay in differential cost. This case management technique was employed in FY '94 at EACH for neonates placed on feed and grow status in Memorial NICU as a stepdown strategy (Cefaly 1994).

It is not surprising, given the aforementioned costs of NICU and post partum pediatric care for premature infants, that considerable debate has ensued over the ethical implications of health care rationing and resource allocation for the high cost of NICU services in the managed care era. In his award winning essay, "Dangerous Economics: Resource allocation in the NICU," Dr. John Zupanic (1992) argues that NICUs have dramatically decreased infant mortality while dramatically increasing economic costs to society. He addresses the ethical concepts of justice, autonomy, beneficence, and the fiduciary relationship of trust between physician and infant. He contends that western society will always project a "women and children first" value where children are viewed as our most precious resource due to the recognition of their potential contributions to society. For this reason, it is very seldom that our paternalism allows us to decline or refuse life-prolonging care to a newborn baby, even when that decision is in the best interests of the child.

4) Summary

The three part literature review has addressed the salient features of the problem statement: altitude effects on

pregnancy in a military population, prediction and prevention of preterm events, and the high cost and associated ethical debate over NICU care. The literature review documents that high altitude pregnancy, especially when combined with other demographic factors, places both mother and infant at increased clinical risk in Colorado Springs. Inferentially, the altitude of Colorado Springs may create a clinical artifact which predisposes increased NICU admissions in transient populations. Second, that preterm risk assessment methodologies, based on multivariate predictor equations, improve the identification of those women at high risk for preterm delivery. Further, the literature reveals that prospective identification of high risk pregnancies, followed by patient education and clinical intervention, can substantially increase gestational term and birthweight. Third, that EACH is presently using a subjective, abridged risk assessment survey and does not have a state of the art prematurity prevention program, which could facilitate a potential reduction in NICU admissions and neonatal acuity of newborns. Fourth, that the provision of NICU care is resource intensive, especially for nursing staff and biomedical equipment. Fifth, that costs and cost avoidance measures presented in the health care economic literature provide operational techniques and guidelines for cost avoidance, which any health care organization considering an NICU venture must consider. And sixth, that the provision of neonatal intensive care has significant bioethical ramifications due to the age and

competence of the patient and the strong social value attached to infants in western culture.

D. Statement of Purpose

The purpose of this graduate management project is to determine by incremental cost analysis of relevant fixed and variable costs, whether EACH should enter the market for Level II NICU services in the Colorado Springs catchment area. The Make/ Buy project evaluation technique will be accomplished through Net Present Value cash flow analysis adjusted for capital risk using LOTUS 123 (Lotus Development Corporation 1988) spread sheet software and @RISK (Palisade 1993) add-in simulation software over a 6 year project life. A sensitivity analysis will be accomplished via systematic combination of input variables to determine a best, worst, and most likely case with a subjective consideration of the project's social value by Delphi panel.

CHAPTER 2

METHOD AND PROCEDURES

A. Overview of Capital Budgeting Method

In Chapter 18 of their financial management text, Berman et. al. (1993) identify a six step capital budgeting model:

1) Project Identification
2) Cash Flow Identification
3) Financial Analysis
4) Benefit Analysis
5) Benefit Evaluation
6) Merger of Financial Analysis and Benefit Evaluation

The method for this study will follow this model with automated augmentation of the financial analysis and benefit analysis by quantitative techniques available through commercial software application programs.

With regard to step one, project identification, Louis Gapenski, in his text Understanding Health Care Financial Management (1993), classifies capital expenditure projects as one of six categories:

1) Mandatory Replacement
2) Discretionary Replacement
3) Expansion of existing products, services or markets
4) Expansion into new products, services or markets
5) Safety/environmental projects
6) Other

This project evaluation of developing a Level II NICU at EACH is a Category 4 project, using Gapenski's taxonomy. Gapenski characterizes this type of project as one which involves the

expenditure of large sums of money over the long term and requires a detailed financial analysis for decision support.

The second step of the Berman et. al. model is cash flow identification which requires the specification of relevant cash flows. With new projects, the relevant cash flows are the incremental cash flows, i.e. only those which would occur if the project were undertaken. For the purpose of the Level II NICU project, the incremental cash flows are additional staffing and salary upgrades, biomedical equipment, facility renovation, ancillary services, and allocated overhead cost necessary to operate a Level II NICU. In a study of CHAMPUS cost avoidance by recapture of services, the capital investment in the NICU will not generate revenue, but will result in reduced expenditure of CHAMPUS funds or operating costs. These expected savings are treated, for the purposes of a financial analysis, as a form of cash inflow (Berman et. al 1993, 534).

Table 1, on the following page, presents the incremental cost categories for the proposed Level II NICU. Those costs that will change with the addition of the project are indicated by the word RELEVANT in column 2. The cost behavior, fixed or variable, from the perspective of an admission to the unit is reflected in column 3. The organizational focus of the cost allocation, direct or indirect, is indicated in column 4. And the method of cost finding or cost basis for stepdown is indicated in column 5.

TABLE 1

INCREMENTAL COST ANALYSIS MATRIX

COST CATEGORY	RELEVANT/ NOT RELEV	FIXED or VARIABLE	DIRECT/ INDIRECT	CALCULATION COST BASIS
PERSONNEL:				
Pediatrician	Not	Fixed	Direct	Contract
Neo Nurse Pract	Not	Fixed	Direct	Contract
Clin Nurse Sp	Relevant	Fixed	Direct	FTE GS-11
Regist. Nurse	Relevant	Fixed	Direct	FTE GS-10
LPN	Relevant	Fixed	Direct	FTE GS-7
RN Upgrade	Relevant	Fixed	Direct	FTE GS-10
LPN Upgrade	Relevant	Fixed	Direct	FTE GS-7
Med Soc Worker	Relevant	Fixed	Direct	FTE GS-11
Clin Case Mgr	Relevant	Fixed	Direct	FTE GS-11
Resp Therapist	Relevant	Fixed	Direct	FTE GS-7
Cytotechnologist	Not	Fixed	Direct	FTE GS-6
Ward Clerk	Not	Fixed	Direct	FTE GS-4
Pharm Tech	Not	Fixed	Direct	FTE GS-5
EQUIPMENT:				
Intens Care Syst	Relevant	Fixed	Direct	Actual
Isolettes	Relevant	Fixed	Direct	Actual
Ventilators	Relevant	Fixed	Direct	Actual
Card-Resp Monitor	Relevant	Fixed	Direct	Actual
Oxygen Analyzer	Relevant	Fixed	Direct	Actual
Pulse Oxymeter	Relevant	Fixed	Direct	Actual
Infusion Pumps	Relevant	Fixed	Direct	Actual
Neonate Xporter	Relevant	Fixed	Direct	Actual
Bilirubin Lamps	Relevant	Fixed	Direct	Actual
Infusion Pumps	Relevant	Fixed	Direct	Actual
FACILITIES:				
Space Conversion	Relevant	Fixed	Direct	Contract
Nursery Upgrade	Relevant	Fixed	Direct	Contract
Antepartum Ward	Not	Fixed	Direct	Contract
ANCIL SERVICES:				
Laboratory	Relevant	Variable	Indirect	MEPRS "D" Pool
Diag Imagery	Relevant	Variable	Indirect	MEPRS "D" Pool
Blood Bank	Relevant	Variable	Indirect	MEPRS "D" Pool
Ambulance	Relevant	Variable	Indirect	Charges
Resp therapy	Relevant	Variable	Indirect	MEPRS "D" Pool
Pharmacy	Relevant	Variable	Indirect	MEPRS "D" Pool
Med Supply	Relevant	Variable	Indirect	MEPRS "D" Pool
ALLOCATED COSTS:				
Linen/Laundry	Relevant	Variable	Indirect	MEPRS "E" Pool
Patient Nutrition	Not	Variable	Indirect	MEPRS "E" Pool
Housekeeping	Relevant	Variable	Indirect	MEPRS "E" Pool
Utilities	Relevant	Variable	Indirect	MEPRS "E" Pool
Patient Spt Div	Relevant	Variable	Indirect	MEPRS "E" Pool
DME	Relevant	Variable	Indirect	MEPRS "E" Pool
Administration	Relevant	Fixed	Indirect	MEPRS "E" Pool

The total dollar charges reflected on the CHAMPUS (MASS) and open allotment database for selected neonatal Diagnosis Related Groups (DRG) 600-630 for FY '94 were initially used to estimate the level of external Level II NICU recapture. The FY '94 nominal costs were inflation adjusted to estimate project year revenues. Only the CHAMPUS government share copayment (80% of allowable charges) for Level II NICU diagnoses were used to calculate the cash inflow.

Analysis of the following DRGs, selected by the chief pediatrician (Dai 1994) provided the incremental case volume which was included in the cost avoidance analysis for Level II NICU recapture at EACH:

DRG	Description
613	Neonate, Birth Wt. 1500-1999 grams, w/o Signif or Proc, w/ Minor problem.
614	Neonate, Birth Wt. 1500-1999 grams, w/o Signif or Proc, w/ Other problem.
619	Neonate, Birth Wt. 2000-2499 grams, w/o Signif or Proc, w/ Minor problem.
621	Neonate, Birth Wt. 2000-2499 grams, w/o Signif or Proc, w/ Other problem.
627	Neonate, Birth Wt. > 2499 grams, w/o Signif or Proc, w/ Major problem.
628	Neonate, Birth Wt. > 2499 grams, w/o Signif or Proc, w/ Minor problem.
630	Neonate, Birth Wt. > 2499 grams, w/o Signif or Proc, w/ Other problem.

(Lorenz, 1993)

It should be noted that these DRGs correlate with the operational definition of neonate acuity which the proposed Level II NICU would admit: infants whose gestational age is greater than 32 weeks and/or birthweight greater than 1499 grams, who do not

require surgical intervention or long term ventilator support. A point estimate of $510 K for 91 cases was projected for recapture using this procedure.

The third step of the Berman et. al. model is Financial Analysis; Gapenski (1993, 416) provides the following five step method:

1) Estimate the capital outlay of the project.
2) Forecast the operating cash flows.
3) Assess the risk of the estimated cash flows.
4) Estimate the cost of capital, given the risk.
5) Assess the profitability over the project life.

The capital outlay of the project is the start up cost for necessary biomedical equipment and nursery renovation. The operating cash out-flows include incremental staff salary expenses, continuing medical education expenses for the staff, medical supply expense, ancillary services utilization and allocated overhead costs. The operating cash in-flows are the CHAMPUS cost recapture and supplemental care savings for contract ambulance transport to civilian hospitals. The risk of the estimated cash flows and cost of capital were set by the Department of Defense discount rate, indexed to a six year project life.

The profitability of the project was assessed using Net Present Value and Internal Rate of Return calculations. A capital budgeting cash flow analysis over a six year project life (Years 0, 1, 2, 3, 4, and 5) was constructed using Lotus 123 spreadsheet software (Gapenski 1993, 428-435). The project's Net Present

Value (NPV) and Internal Rate of Return (IRR) were further explored by risk simulation. Using @RISK add-in software from Palisade Corporation, parameters in the spreadsheet were subjected to Latin Hypercubic sampling of their underlying probability distributions to generate confidence intervals for the expected NPV and IRR value. A systematic sensitivity analysis of input variables was used to discover optimum, minimum, and most likely case scenarios.

Step four of the Berman et. al. model, benefit analysis, was accomplished via a Delphi panel of expert opinion using a survey instrument to quantify project benefits based on Avedis Donabedian's (1984) paradigm of quality for patient care.

Step five of the Berman et. al. model, benefit evaluation, was accomplished through the application of the Judging Utility: A Decision Generator and Evaluator (JUDGE) model (Finstuen 1994). The JUDGE model is a quantitative technique to differentiate a decision space among alternatives and enhances respondents' discrimination among alternatives based on their ratings of attributes of those alternatives. The survey instrument was constructed to facilitate the application of the JUDGE model's quantitative technique.

Step six of the Berman et. al. model, the merger of financial and benefit evaluation will comprise the third and fourth chapters (Results and Discussion) of the study.

B. Incremental Costing Procedures

Within the methodology overview section, a matrix of incremental costs for the NICU project was presented.
In this section, the derivation of input values for the cash flow analysis spreadsheet is presented in the following sequence: NICU Cost Recapture, Volume Projections, Equipment, Staffing, Ancillary Services, and Administrative Overhead.

1) NICU Cost Recapture

Perhaps the most important incremental cost relevant to the project is the historic CHAMPUS and open allotment costs associated with NICU services in the Colorado Springs catchment area. In FY '94, EACH experienced 1,705 births of which 79.2 percent (1,351 cases) were DRG 391, normal newborn. The remaining 354 births were classified into DRGs 600 through 630 (Mantia 1995). The USAFA Hospital neonatal discharge data for FY '94 reflect 624 births of which 81.6 percent (501 cases) where normal newborn. Table 2, on page 33, presents a tabular summary of FY '94 neonatal diagnoses for both MTFs in the Colorado Springs combined catchment and those cases issued a NAS for CHAMPUS.

The summary data at the bottom of Table 2 reveal that the treatment of newborns represents 13.8 percent of all discharges in the Colorado Springs catchment and 14.3 percent of all MTF discharges. Roughly one of every seven of the combined discharges

TABLE 2
FY'94 DISCHARGE DIAGNOSES BY PAYOR AND FACILITY

DRG	DESCRIPTOR	CHAMPUS USAFA	CHAMPUS EACH	MTF USAFA	MTF EACH	TOTAL CHAMPUS	TOTAL MTF	GRAND TOTAL
391	Normal Newborn	8	20	501	1351	28	1852	1880
600	Neonate, Died within 1 day of birth	1	0	1	6	1	7	8
601	Neonate, Transferred <5 days old	0	0	13	40	0	53	53
602	Neonate, BW < 750 G, Dischg'd alive	0	0	0	0	0	0	0
603	Neonate, BW <750 G, Died	0	1	0	0	1	0	1
604	Neonate, BW 750-999 G, Dischg'd alive	0	3	0	0	3	0	3
607	Neonate, BW 1000-1499 G, w/o SIGNIF or PROC, discharged alive	1	4	0	0	5	0	5
609	Neonate, BW 1500-1999 G, w/ SIGNIF or PROC, w/ Multiple major problems	1	1	0	0	2	0	2
611	Neonate, BW 1500-1999 G, w/o SIGNIF or PROC, w/ Multiple major problems	1	1	0	0	2	0	2
612	Neonate, BW 1500-1999 G, w/o SIGNIF or PROC, w/ major problem	2	1	1	2	3	3	6
613	Neonate, BW 1500-1999 G, w/o SIGNIF or PROC, w/ minor problem	1	3	0	0	4	0	4
614	Neonate, BW 1500-1999 G, w/o SIGNIF or PROC, w/ other problem	0	2	2	1	2	3	5
617	Neonate, BW 2000-2499 G, w/o SIGNIF or PROC, w/ Multiple major problems	1	1	0	1	2	1	3
618	Neonate, BW 2000-2499 G, w/o SIGNIF or PROC, w/ major problem	0	2	1	4	2	5	7
619	Neonate, BW 2000-2499 G, w/o SIGNIF or PROC, w/ minor problem	0	2	1	3	2	4	6
621	Neonate, BW 2000-2499 G, w/o SIGNIF or PROC, w/ other problem	2	3	6	29	5	35	40
622	Neonate, BW > 2499 G, w/ SIGNIF or PROC, w/ multiple major problems	1	2	0	0	3	0	3
623	Neonate, BW > 2499 G, w/ SIGNIF or PROC, w/o multiple major problems	1	0	0	1	1	1	2
626	Neonate, BW > 2499 G, w/o SIGNIF or PROC, w/ Multiple major problem	1	5	1	2	6	3	9
627	Neonate, BW > 2499 G, w/o SIGNIF or PROC, w/ major problem	10	9	10	24	19	34	53
628	Neonate, BW > 2499 G, w/o SIGNIF or PROC, w/ minor problem	0	5	11	36	5	47	52
630	Neonate, BW > 2499 G, w/o SIGNIF or PROC, w/ other problem	1	13	77	205	14	282	296
RECAPITULATION of NEONATAL DRGs		32	78	625	1705	110	2330	2440
TOTAL DISCHARGES		484	845	6309	9998	1329	16307	17636
PERCENTAGE OF ALL DISCHARGES		6.61%	9.23%	9.91%	17.05%	8.28%	14.29%	13.84%

from both MTFs was a neonate. It is important to note that the FAMC NICU was still operational through the end of FY '94 and the data in Table 2 do not reflect cases referred to the NICU at Fitzsimons from Colorado Springs.

To find these costs it was necessary to query the Retrospective Case Mix Analysis System for an Open System Environment (RCMAS-OSE) and Medical Analysis Support System (MASS) databases. The RCMAS-OSE database was queried for an ad hoc sort by DRGs 613, 614, 619, 621, 627, 628, and 630 of FY '94 government cost paid to health care providers and hospitals for patients in the Colorado Springs catchment. This sort produced a break out of provider and hospital CHAMPUS costs paid for each of the patient cases by each DRG targeted for recapture, given the admission constraints of the proposed Level II NICU. The total cost of provider and hospital charges paid by the government was consolidated across patients for each DRG.

In order to estimate a CHAMPUS equivalent cost for the neonates treated at the FAMC NICU in the seven DRGs under study, an average cost and standard deviation were calculated using RCMASE-OSE cost data for Colorado Springs during FYs '90 through '94. This data is presented in Table 3 on page 35.

The number of FAMC NICU referrals by DRG were multiplied by the average cost in the Colorado Springs catchment and this product was added to the FY '94 totals from the RCMAS-OSE query. The FY 1994 estimated recapture for the Level II NICU was

$509,761 for 91 total cases. The recapture breakout tabulation by facility and DRG is presented in Table 4.

TABLE 3

AVERAGE COST OF LEVEL II NICU DRGs
FY '90 - FY '94

DRG	FAMC Referrals	Average Cost	Standard Deviation
613	2	$16,872	$2,980
614	0	17,123	3,550
619	2	5,927	1,593
621	6	4,851	1,448
627	11	7,664	2,060
628	5	3,242	1,192
630	14	1,247	335

Source: RCMAS-OSE database

TABLE 4

ESTIMATED LEVEL II NICU RECAPTURE

DRG	EACH	USAFA	FAMC	Cases	Cost
613	1	3	2	6	$100,970
614	2	0	0	2	34,977
619	2	0	2	4	23,876
621	3	2	6	11	54,480
627	9	10	11	30	231,618
628	5	0	5	10	31,512
630	13	1	14	28	32,328
TOTAL	35	16	40	91	$509,761

Source: Derived data for FY 1994

Due to the low case frequency in some DRGs, (DRG 614 had only two cases in 1994) and variability in the number of cases per year, an inflation-adjusted projection of CHAMPUS cost recapture using only a year's historical case data for the project's out-years was unreliable. Therefore, a demography-based method of case volume projection was developed.

2) Volume Projections

In order to determine the incremental number of Level II NICU cases for the project, it was necessary to research population and birth data for the Colorado Springs catchment. Using the RCMAS-OSE and DMIS databases to derive key statistics from historical data, the catchment growth rate (CGR), number of women of child-bearing years, birth rate per 1000 women, incidence rates for those DRGs targeted for recapture, and average length of stay (ALOS) by DRG were calculated.

Figure 1, on page 37, depicts the catchment population for Colorado Springs and its steady growth during the past 4 years. Note that the population has grown by roughly 4,000 beneficiaries each year from 1993 to 1995. Growth from 1992 to 1993 was 1.9%; from 1993 to 1994 it was 3.0%, and from 1994 to 1995 it was 2.9%. Due to force realignment, the catchment population will decrease during FY 1996 by an estimated 2700 active duty soldiers and 5600 dependents (Downs 1995). Therefore, the catchment will decrease by approximately 8,300 to 125,800 in FY 1996.

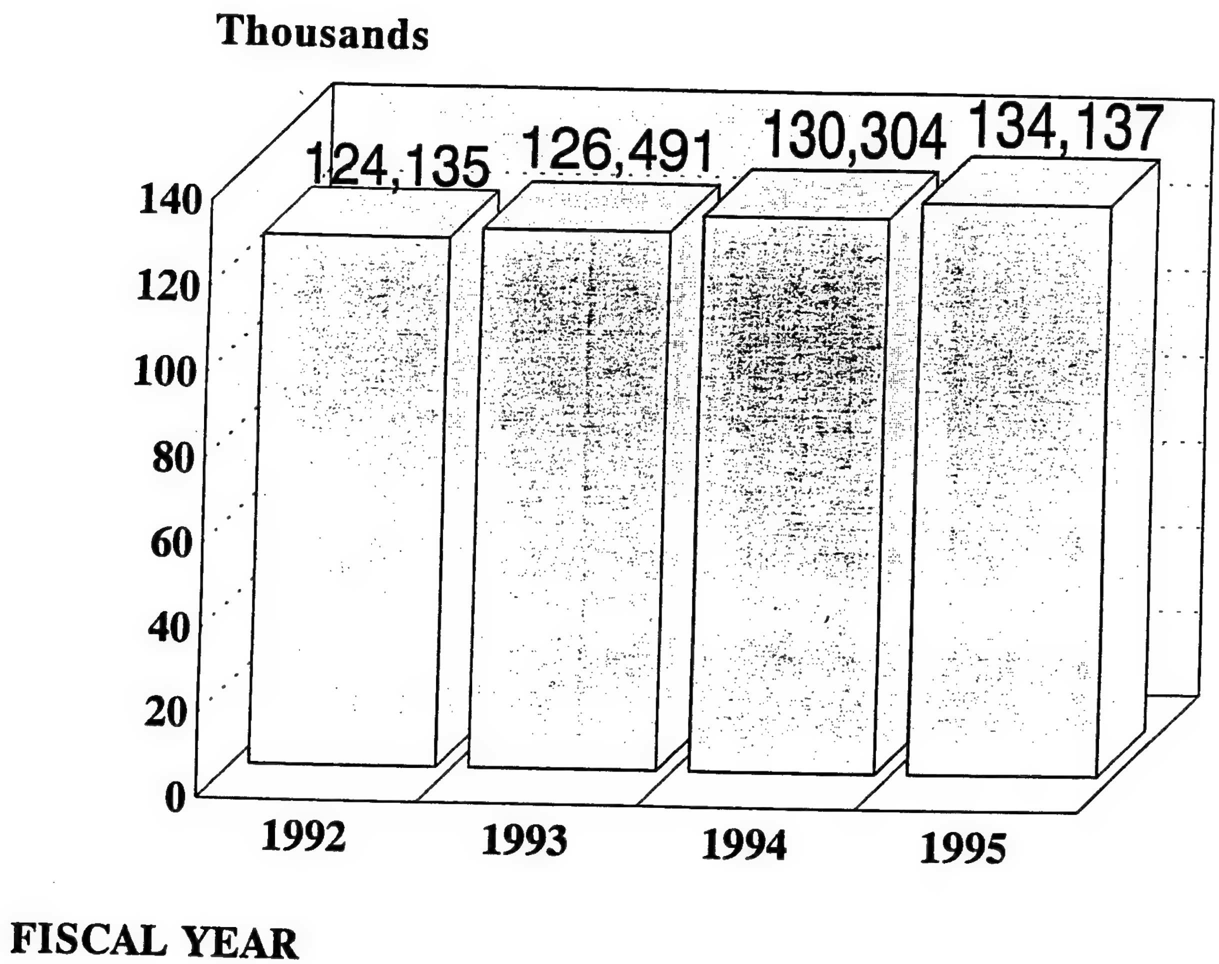

Figure 1. Colorado Springs catchment population growth during FY 1992 through FY 1995. Source: DMIS database

The number of females in the population and the maternal age of delivery were used to determine the ages of those mothers having children in the catchment area. It was necessary to determine the number of women in this child-bearing age group to develop a birthrate per 1000 women of child-bearing age in the catchment. Figure 2 on page 39, depicts the maternal age at delivery for 1660 births at EACH during FY 1994. Note that the youngest mother was 13 while the eldest was 44! The frequency distribution is skewed right with the mode of 171 births at 20 years old and a mean age of 23.4 years. Additionally, 23% of all deliveries were by teenage mothers, aged 13 to 19 years. Based on this data, the number of women between age 15 and 45 years in the catchment area was selected. Table 5 reveals that the child-bearing age population was 29,750 of a total female population of 63,365.

TABLE 5

FY '94 CATCHMENT FEMALES BY AGE GROUP

Age Group	EACH	USAFA	TOTAL	BLOCK
0 - 4	4364	1416	5780	
5 - 14	6802	3027	9829	15609
15 - 17	1620	1033	2653	
18 - 24	6217	2751	8968	
25 - 34	7070	2865	9935	
35 - 44	4820	3374	8194	29750
45 - 64	6906	5651	12557	
65 - UP	3216	2233	5449	18006
TOTAL	41015	22350	63365 =	63365

Source : DMIS database FY '94

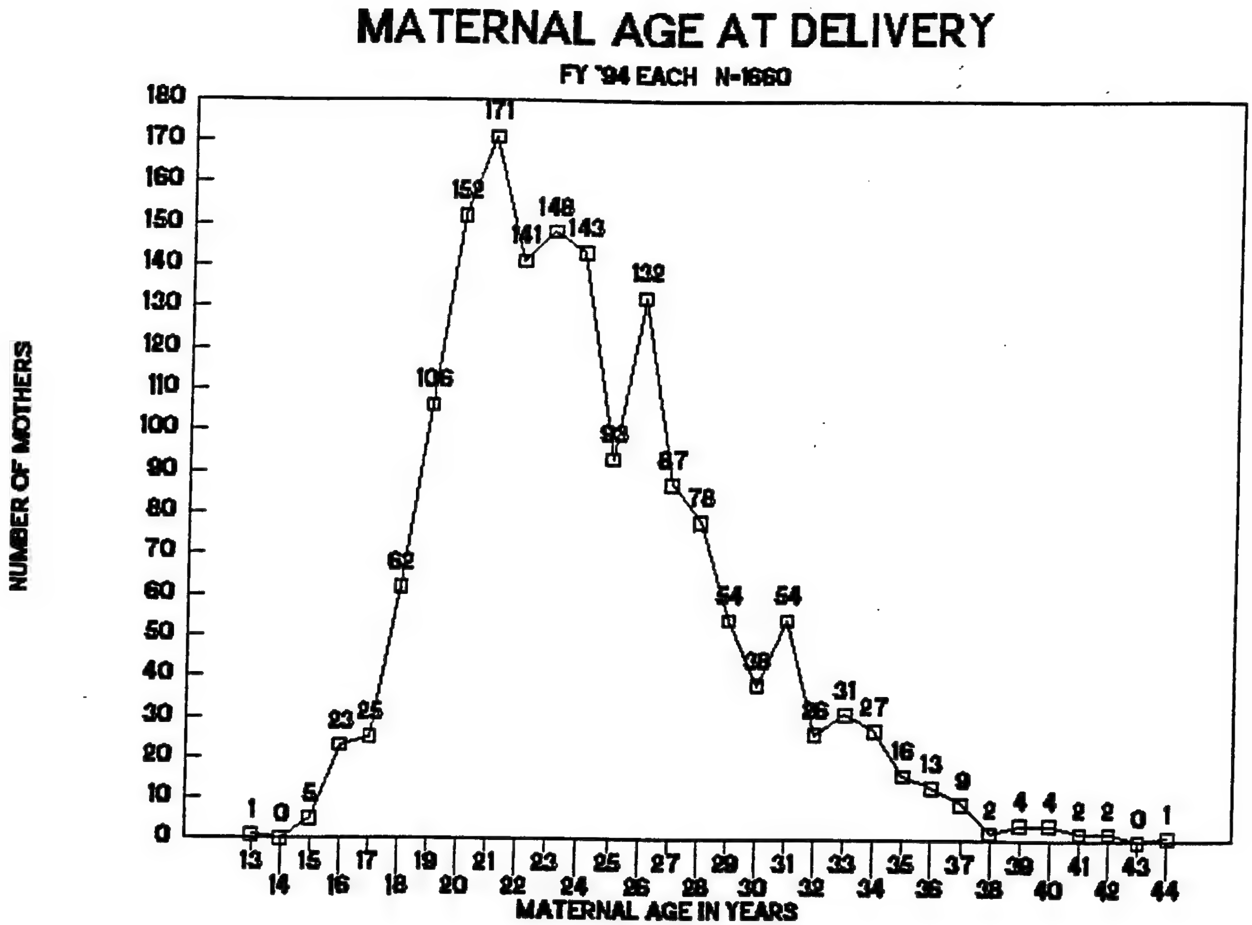

Figure 2. Maternal age at time of Delivery for FY 1994 at Evans Army Community Hospital. Source: RCMAS-OSE database.

A five year historical review, using RCMAS-OSE and DMIS data base queries for the females in the catchment population, revealed the following catchment information:

TABLE 6

BIRTH RATE (BR) PER 1000 CHILD-BEARING WOMEN

Fiscal Year	Catchment Population	Number of Females	Women 15-45 yrs.	Births	BR/ 1000
1994	130304	63365	29750	2441	82
1993	126135	61573	29143	2308	79
1992	124129	60591	28538	2381	84
1991	121386	58543	26402	2109	80
1990	119958	55904	25437	2061	81

Source: Combined data DMIS and RCMAS-OSE databases

The knowledge gained from the preceding database queries reveals that the catchment population over the past five years has included a child-bearing aged segment of 25 to 30 thousand women, who bear between 2000 to 2500 children annually. Note the decrease in birth rate from 81 births per 1000 in FY '90 to 80 births per 1000 in FY '91 followed by the large increase to 84 births per 1000 in FY '92. Military hospital personnel refer to this effect as Operation "Desert Stork" due to the associated birth rates following mass redeployment of thousands of servicemen and women from the Persian Gulf War.

The final key to the demography-based, case volume projection of CHAMPUS recapture was a historical incidence rate

of each neonatal diagnoses in the catchment's total births. The RCMAS-OSE database was queried for the number of total births and neonatal DRG frequency for FY 1990 through FY 1994. Table 7 provides the average, minimum, and maximum incidence rates in the newborn population for each of the Level II NICU DRGS encountered over the five years from FY '90 to FY '94.

TABLE 7

5 YEAR HISTORICAL INCIDENCE RATES
FOR SELECTED NEONATAL DRGS

DRG	Average	Minimum	Maximum
371	0.7560	0.7490	0.7710
613	0.0099	0.0025	0.0043
614	0.0021	0.0000	0.0025
619	0.0035	0.0023	0.0044
621	0.0191	0.0151	0.0230
628	0.0234	0.0165	0.0302
630	0.1250	0.1197	0.1333

Source: Calculated data from RCMAS-OSE FY '90 - '94

With the information derived from knowledge work with the DMIS, MASS, and RCMAS-OSE databases and the probability distribution functions available using @RISK with the LOTUS 123 spreadsheet, it was now possible to construct a model to simulate the case volume in the DRGs based on the size of the catchment population. Using the summary statistics presented in Tables 3, 5, 6, and 7 the conceptual model follows:

CATCHMENT POP X (1 + CATCHMENT GROWTH RATE) X Percent of CHILD-BEARING FEMALES X Birthrate per 1000 X DRG_i Incidence = DRG_i Vol

By building in the probability function @TRIANGULAR and specifying the minimum, most likely (average) and maximum incidence rates for the DRG_i term, the simulation can vary the incidence rate of each DRG within experience limits in the child bearing population at Colorado Springs.

Using the average cost and standard deviation of the Level II NICU DRGs from Table 3, and the probability function @TNORMAL from @RISK, the simulation can iteratively sample a CHAMPUS recapture cost from a truncated normal range. Using the spreadsheet to calculate the sum of each DRG's volume multiplied by the sampled average cost for each DRG across the seven Level II DRGs, a total recapture cost is calculated for each iteration. However, this cost is not an incremental cost, as some of the volume in each DRG has historically been recaptured. In order to refine the formula for total recapture cost it is necessary to subtract the cases treated in the MTFs from the number of cases generated by the simulation. This differential is the number of incremental cases which would be granted a CHAMPUS NAS. Using the incremental case volume and the sampled average cost, the formula for incremental recapture becomes:

$$@SUM\ ((DRG_{613}\ Cases^{sim} - DRG_{613}\ MTF)*\ DRG_{613}\ Cost^{sim} + \ldots$$
$$(DRG_{630}\ Cases^{sim} - DRG_{630}\ MTF)*\ DRG_{630}\ Cost^{sim})$$

The formula generates the incremental cost of recapture based on simulation generated case volume and simulation generated average cost per case across the seven Level II DRGs , within limits set by actual historical experience in Colorado Springs. This procedure provides a better estimate of projected recapture than simple propagation of the FY '94 recapture estimate indexed for inflation.

The other cost available for recapture is the contract neonatal transport charges which are incurred when transporting a neonate to civilian hospitals. The charge for a basic transport is $750. If a clinical transport team is required due to the medical condition of the infant and stability of vital signs the charge is $1500. These charges are disbursed from the open allotment direct care account. In FY '94 the open allotment charges for neonatal transport of the 91 Level II cases was $45,473. Due to difficulty in tracing a specific transport charge to the neonate's discharge DRG and the occasional use of one transport for multiple infants, a cost formula for transport recapture was not attempted. Instead, the FY '94 amount was propagated to the project out-years with an inflation adjustment.

In summary, the cost avoidance for Level II NICU neonates used in the financial analysis is comprised of a simulation-generated incremental cost of the government share CHAMPUS cost of selected DRGS and historic neonatal transport charges. Both cost components are indexed for inflation over the project life.

3) Equipment

To determine the incremental cost of equipment, a list of required equipment to support a 12 bed NICU, which was previously generated (Badgett 1994b), was reviewed. An equipment inventory with the nursery wardmaster (Warner 1995) and assessment of the useable life of the available equipment, using the biomedical maintenance database and expert opinion (AMEDPAS, Navarro 1995), revealed a substantial gain against the requirements from the initial estimate. That gain was primarily facilitated through the transfer of nursery biomedical equipment from the FAMC NICU.

Table 8, on page 45, provides a itemized list of on hand equipment, the required quantity, the incremental quantity, and item cost. A roll up total cost of $193,807 was calculated using this procedure. A check of the AMEDPAS database revealed that the Bear Cub ventilator was due for replacement due to service history and age of the device. All other existing equipment had a minimum remaining service life of at least 7 years and no adverse maintenance history (Navarro 1995). The replacement cost for the Bear Cub with an Infrasonic is included in the start up equipment cost of the project.

The installation of four intensive care systems (ICU pillars), the oxygen outlets, electrical power, and renovation of the nursery to segregate the NICU from the routine nursery has an estimated contract cost of $200K, as estimated by the facility

TABLE 8

INCREMENTAL BIOMEDICAL EQUIPMENT REQUIREMENTS FOR LEVEL II NICU

Biomed Equipment Nomenclature	REQUIRED Quantity	ON HAND Quantity	INCREMENT Quantity	UNIT COST	TOTAL COST
Intensive Care Syst	10	6	4	$20,000.00	$80,000.00
Isolettes	2	2	0	$9,210.00	$0.00
Neonate Transporter:					
w/ Ventilator	1	1	0	$50,059.81	$0.00
w/o Ventilator	2	2	0	$9,319.00	$0.00
Cardio-Resp Monitor	12	6	6	$8,775.02	$52,650.12
Oxygen Analyzer	12	6	6	$595.00	$3,570.00
Ventilators:					
Bear Cub	1	Obsolete	0	$5,070.54	$0.00
Sechrist	1	1	0	$8,253.03	$0.00
Infrasonic	3	2	1	$8,965.16	$8,965.16
Pulse Oxymeter	12	6	6	$3,509.54	$21,057.24
IV Infusion Pump	16	8	8	$1,293.59	$10,348.72
Syringe Infusion Pump	8	4	4	$1,615.46	$6,461.84
Bilirubin Lamps:					
Banks	8	8	0	$8,603.00	$0.00
Spots	12	4	8	$1,344.21	$10,753.68
Cribs	36	36	0	$863.00	$0.00
Radiant Heaters	8	8	0	$3,021.79	$0.00
TOTAL INCREM EQUIPMENT COST:					$193,806.76

Source: AMEDPAS

engineer, in logistics. This renovation and installation cost was also included as a start up cost for the project.

4) Staffing

Perhaps the most significant incremental cost to the proposed Level II project, after the start up costs of biomedical equipment and nursery renovation, is clinical staffing. In the NICU Economic Studies section of the literature review in Chapter 1, nursing staff was 51 percent of the operating cost in the Dublin, Ireland study by Connolly et. al. (1989). An incremental staffing estimate for the Level II NICU project had already been completed (Badgett 1994b) with an associated cost estimate of \$367,113. In a later revision of that memorandum (Badgett 1994c), a more refined estimate for Level III NICU requirements added salary breakdown, salary upgrades and General Schedule (GS) grades, and included ancillary service personnel. Using the combined information from both documents, a comprehensive listing of all staffing requirements to meet Level II or Level III requirements and salary costs was built-in to the LOTUS Spreadsheet for financial analysis. The incremental staffing and projected nominal cost in FY '95 was then propagated to the project's cash flow analysis, after indexing for inflation. The incremental staffing analysis is presented in Table 9 on page 47 and reflects a FY '95 nominal cost of \$380,153. The pediatrician and neonatal nurse practitioner personnel would not receive

TABLE 9

INCREMENTAL STAFFING FOR LEVEL II NICU

Position	INCREM	SALARY	BASIS	COST
Clinical Staff:				
Pediatrician	0.0	$148,400	Contract	$0
Neo Nurse Pract	0.0	$77,316	Contract	$0
Clin Nurse Spec	1.0	$51,961	GS-11	$51,961
Reg. Nurse	2.5	$48,235	GS-10	$120,588
LPN	2.0	$29,061	GS-7	$58,122
R.N. Upgrade	3.5	$6,500	GS-9 to 10	$22,750
LPN Upgrade	7.0	$2,457	GS-6 to 7	$17,199
Nursing Asst.	0.0	$23,364	GS-4	$0
Ancillary Staff:				
Med Soc Worker	1.0	$47,928	GS-11	$47,928
Clin Case Mgr	1.0	$48,535	GS-10	$48,535
Respir Therap	0.0	$34,180	GS-7	$0
Pharmacy Tech	0.5	$26,140	GS-5	$13,070
Cytotechnologist	0.0	$29,137	GS-6	$0
Ward Clerk	0.0	$23,364	GS-4	$0
TOTAL INCREMENTAL PERSONNEL COST:				$380,153

Source: (Badgett 1994b and 1994c)

sufficient salary on the General Schedule, even at GS-15 pay; therefore, the salary costs are estimates of the contract consideration required to attract these clinicians from the local medical economy.

It should be noted that the analysis in Table 9 is predicated upon the assumption that EACH will have a board-certified pediatrician on military staff. Currently, all U.S Army pediatricians are board eligible but may not be board certified. Board certification in pediatrics, as a credential for the Level II NICU medical director, is one of several requirements for Level II certification of the facility (JCAHO 1994).

5) Ancillary Services

Two cost allocation methods are prevalent in cost finding. The top down method is most typical and uses a stepdown, double stepdown, or simultaneous equations method, whereby non-revenue producing cost centers allocate pooled costs to revenue producing centers on the basis of a selected cost driver. The bottom up method is less common and probably best represented by William O. Cleverly's product line costing (Cleverly 1992, 259). Product line costing develops a standard cost profile for each product line, e.g. delivery of term neonate, by seeking to establish all the individual costs which are incurred

in the typical provision of the product and includes both direct and indirect costs.

EACH has not yet converted to the Composite Health Care System (CHCS), a medical information system which provides integrated database information from clinical, logistic, ancillary services, and patient administration areas. CHCS could provide patient specific integrated data which would greatly facilitate the development of a bottom up cost finding method. The existing cost accounting system at EACH is the Medical Expense and Performance Reporting System (MEPRS) which employs a top down approach of indirect cost allocation through the double step down method. As a top down method, MEPRS tends to overstate allocated costs due to the bias inherent in selecting a single cost driver for the allocation of pooled costs.

In order to discover the incremental cost of ancillary services (laboratory, pharmacy, diagnostic imagery, blood bank), a method to project the MEPRS cost driver for incremental Level II neonate admissions was required. The MEPRS Stepdown Assignment Statistic (SAS) for the newborn nursery for the ancillary services cost pool (MEPRS D accounts) is Occupied Bed Days (OBD). In order to generate OBD from the projected Level II DRG diagnoses, the simulation capability of @RISK and the probability distribution for average length of stay were required.

The spreadsheet generates the incremental Level II neonate cases based on input parameters of catchment growth rate (CGR) birth rate per 1000 child-bearing aged females (BR) and the historical incidence rates of the seven Level II DRGs in Colorado Springs. Using historical CHAMPUS data for average length of stay, minimum length of stay, maximum length of stay and standard deviation for Fiscal Year '94, the unit normal probability distribution function (@NORMAL) in @RISK was used for simulation of length of stay in each Level II NICU DRG.

Table 10, below, presents the length of stay data used as arguments for the @NORMAL probability distribution function.

TABLE 10

LENGTH OF STAY STATISTICS FOR LEVEL II NEONATAL DRGS

DRG	ALOS	STD DEV	MIN	MAX
613	14.7	4.33	1	31
614	8.6	2.73	1	25
619	6.8	2.31	1	23
621	3.0	1.75	1	10
627	3.4	1.51	1	13
628	3.3	0.90	1	9
630	2.1	0.68	1	5

Source: MASS Database FY '94

The spreadsheet formula for OBD uses the number of cases generated by the simulation in each of the seven Level II neonatal DRGs and multiplies each DRG's case volume by the length of stay sampled from the normal distribution using the summary statistics from Table 10.

In theory, the expected OBDs for the seven neonatal DRGs under study for recapture in the project are represented by the spreadsheet formula:

$$@SUM((DRG_{613} * @NORMAL(DRG_{613}\ ALOS,\ DRG_{613}\ Std\ Dev) + (DRG_{i}\ Cases * @NORMAL(DRG_{i}\ ALOS,\ DRG_{i}\ Std\ Dev) + \ldots + (DRG_{630} * @NORMAL(DRG_{630}\ ALOS,\ DRG_{630}\ Std\ Dev))$$

The summation of DRG specific OBD across DRGs 613, 614, 619, 621, 627, 628, and 630 produces the total OBD for the Level II NICU based on demography and sampling of catchment specific probability distributions.

To refine the OBD spreadsheet formula for incremental bed days for the purpose of deriving a MEPRS cost formula for ancillary services, it was necessary to remove the OBD for each of the seven DRGs which were recaptured in FY '94. Therefore, the previous formula takes the following form:

$$@SUM((DRG_{613}\ Cases^{sim} * @NORMAL(DRG_{613}\ ALOS,\ DRG_{613}\ Std\ Dev)) - DRG_{613}\ OBD_{MTF} + ((DRG_{i}\ Cases^{sim} * @NORMAL(DRG_{i}\ ALOS,\ DRG_{i}\ Std\ Dev)) - DRG_{i}\ OBD_{MTF} + \ldots + ((DRG_{630}\ Cases^{sim} * @NORMAL(DRG_{630}\ ALOS,\ DRG_{630}\ Std\ Dev)) - DRG_{630}\ OBD_{MTF}$$

Essentially, this formula is a summation of the differences between total expected OBD and the total MTF OBD for each of the seven neonatal DRGs. The formula generates the total incremental Level II NICU OBD which are relevant for project recapture.

Using the FY '94 MEPRS Expenses Analysis report for the newborn nursery, the D account expenses (Pharmacy, Clinical

Pathology, Diagnostic Radiology, Blood Bank, Respiratory Therapy, and Nuclear Medicine) charged to the nursery account totalled $289,615 for 2610 OBD (MEPRS 1994). Using 2610 OBD as the cost basis, the incremental cost of X additional bed days is represented by the equation ($289,615/2610)* X. This formula is indexed for inflation by multiplying the proportional product by the term $(1+i)^{PY}$, where i is the annual rate of inflation and the exponent PY is the cardinal number of the project out-year.

For example, the incremental ancillary services cost of 300 additional OBD on the NICU in the second project year with an annual rate of inflation of three percent is calculated as follows:

$$(\$289,615/2610) * 300 * (1 + .03)^2$$

$$\$110.96 * 300 * 1.0609$$

$$\$35,316.51$$

This method of calculating ancillary services cost is less accurate than a direct costing method and should overstate the cost of ancillary services. As no other costing methodology was tenable, due to the lack of an integrated medical information system, an overstated estimate of ancillary services was more conservative for the project's cash flow analysis.

6) Administrative Overhead

To determine the relevant incremental overhead expenses using MEPRS cost data, a similar proportion type formula, based

on OBD and indexed for inflation, was created in the spreadsheet model. Using the MEPRS E cost pool expenses charged to the nursery, the total administrative overhead cost allocated to the nursery account for FY '94 was $149,945 (MEPRS 1994).

Using the MEPRS E account SAS of 2610 OBD as the cost basis for the nursery's administrative overhead expenses, the incremental cost of X additional bed days for Level II neonates is represented by the spreadsheet formula ($149,945/2610) * X. Indexing for inflation with the term $(1 + i)^{PY}$ as before, the formula becomes:

$$(\$149{,}945/2610) * \underline{X} * (1 + i)^{PY}$$

Where X = incremental OBD,
i = annual rate of inflation, and
PY = cardinal number of project year.

To determine the incremental administrative overhead cost of 300 additional OBD in the second project year with an annual rate of inflation of three percent, as in the preceding example for ancillary services, the cost is calculated as follows:

$$(\$149{,}945/2610) * 300 * (1 + .03)^2$$

$$\$57.45 * 300 * 1.0609$$

$$\$18{,}284.67$$

Once again, as a result of using the MEPRS expense analysis, the cost of administrative overhead is most likely overstated using this method. However, the cash flow analysis is, as a result, a more conservative estimate of the project's profitability.

This completes this section on incremental costing procedures. In summary, the procedures for developing a demography sensitive, simulation generated, probability based spreadsheet model of incremental costs was presented. The formulae, probability distributions sampled by the simulation, and arguments of those probability functions were also developed from the synthesis of multiple databases' information. The logic for generating the relevant incremental cash flows of operating costs avoided (revenues) and expenses (start up costs for equipment and renovation, and the annual costs for staffing, ancillary services, and administrative overhead) were detailed. The next major section of this chapter assimilates and organizes the preceding discussion into a concise decision support system, using a Lotus spreadsheet with risk analysis simulation.

C. Spreadsheet Model

Table 11, on the following page, presents the Lotus 123 spreadsheet created to simulate and calculate the incremental case volume, occupied bed days, and resulting cash flow for the Level II NICU project at EACH. The profitability of the cash flow analysis is evaluated over a six year project life, with FY 1995 as the start up year and FY 1996 through FY 2000 as the operating years.

Generally, the spreadsheet is designed in four major sections. The uppermost area of the spreadsheet contains input

TABLE 11

LEVEL II NICU PROJECT EVALUATION
Five Year Incremental Analysis

INPUT VARIABLES:			
Discount Rate	4.000%	Trng/ CME	$20,000
Inflation Rate	2.500%	NURSY OBD	2610
Births per 1000 females	82.000	ANCIL SVCS	$289,615
CATCHMENT Growth Rate	2.000%	ADMIN OVHD	$145,945
FY'94 NICU Recapture	$509,761		

OUTPUT VARIABLES:
Nominal Salary $380,153

5 YEAR VOLUME PROJECTION:

FY '94 BASELINE	BIRTHS	INCREM OBD
	2441	383
1996	2330	320
1997	2376	346
1998	2424	373
1999	2472	400
2000	2522	428
TOTAL	12123	1868

NPV of PROJECT $39,700

INTERNAL RATE OF RETURN 7.45%

QTY	CLINICAL STAFF		SALARY
0	Pediatrician		$148,400
0	Neonatal Nurse Pract		$77,316
1	Clinical Nurse Sp	(GS-11)	$51,961
2.5	Registered Nurse	(GS-10)	$48,235
2	Lic Pract. Nurse	(GS-7)	$29,061
3.5	R.N. Upgrade	(GS-9 to 10)	$6,500
7	LPN Upgrade	(GS-5 to 6)	$2,457

AVG COST PER DISCHG	FY '94 (@TNORMAL)
DRG 613	$18,602
DRG 614	$18,878
DRG 619	$6,535
DRG 621	$5,349
DRG 627	$8,450
DRG 628	$3,574
DRG 630	$1,375

AVG COST INDEX 5.00%

QTY	ANCILLARY STAFF		
1	Med Soc Worker	(GS-11)	$47,928
1	Clin Case Mgr	(GS-10)	$48,535
0	Respir Therap	(GS-7)	$34,180
0.5	Pharmacy Tech	(GS-5)	$26,140
0	Cytotechnologist	(GS-6)	$29,137
0	Ward Clerk	(GS-4)	$23,364

VOLUME PROJECTIONS

		FY'94 ACTUAL	FY '96	FY '97	FY '98	FY '99	FY 2000
CATCHMENT Population		130304	124429	126917	129456	132045	134686
FEMALES AGE 15-44 YRS		29750	28409	28977	29556	30147	30750
TOTAL Births		2440	2330	2376	2424	2472	2522
[5 Year Historical]	(@TRIANG)						
DRG 391 Incidence Rate:	0.7599	1880	1770	1806	1842	1878	1916
DRG 613 Incidence Rate:	0.0025	4	6	6	6	6	6
DRG 614 Incidence Rate:	0.0020	5	5	5	5	5	5
DRG 619 Incidence Rate:	0.0032	6	7	8	8	8	8
DRG 621 Incidence Rate:	0.0190	40	44	45	46	47	48
DRG 627 Incidence Rate:	0.0262	53	61	62	63	65	66
DRG 628 Incidence Rate:	0.0234	52	54	56	57	58	59
DRG 630 Incidence Rate:	0.1250	296	291	297	303	309	315
ROUTINE & LEVEL II TOTALS	0.9611	2336	2239	2284	2329	2376	2423

MTF OCC BED DAY BY DRG	ALOS	FY '94 ACTUAL	INCREMENTAL RECAPTURE: OCCUPIED BED DAYS to BASELINE				
BASELINE FY '94	(@NORMAL)	NAS OBD					
DRG 613 (0 OBD)	14.70	93	86	87	89	91	93
DRG 614 (25 OBD)	8.60	19	15	16	17	18	18
DRG 619 (27 OBD)	6.80	32	23	24	25	26	27
DRG 621 (107 OBD)	3.00	34	26	28	31	34	37
DRG 627 (126 OBD)	3.40	106	82	86	90	94	99
DRG 628 (138 OBD)	3.30	38	42	45	49	53	56
DRG 630 (564 OBD)	2.10	61	47	60	72	85	98
Incremental OBD		383	320	346	373	400	428

CASH FLOW ANALYSIS	YEAR: FY '95	'96	'97	'98	'99	2000
	0	1	2	3	4	5
1. Biomed Equipment	($193,807)					
2. Nursery Renovation	($200,000)					
3. CHAMPUS Recapture		$490,835	$536,553	$584,936	$636,119	$690,246
4. Suppl Care Recapture		$46,610	$48,969	$52,735	$58,209	$65,858
5. Net Cost Avoidance		$537,445	$585,523	$637,671	$694,329	$756,104
6. Less Salary		$389,656	$409,383	$440,860	$486,627	$550,574
7. Less Training/CME		$20,000	$20,500	$21,013	$21,538	$22,076
8. Less Ancil Svcs		$36,425	$40,384	$44,580	$49,026	$53,735
9. Less Admin. Overhead		$18,356	$20,351	$22,465	$24,706	$27,079
NET CASH FLOW	($393,807)	$73,008	$94,905	$108,752	$112,431	$102,640
NET PRESENT VALUE	$39,700					
INTERNAL RATE OF RETURN	7.45%					

and output variables which are used in calculations in the lower three areas of the spreadsheet. The second area, under the caption, "Volume Projections," generates the number of cases in each of the Level II DRGs over the project life based on input parameters of catchment population, catchment growth rate, child-bearing female compliment, birth rate per 1000 women 15 through 45 years of age in the catchment, and a triangular probability function (@D) of the historical incidence rate of neonatal DRGs over a five year baseline. The third area, under the caption, "Incremental Recapture: Occupied Bed Days to Baseline," generates the number of incremental OBD based on the DRG volume projections, average length of stay, and baseline OBD in the MTF for FY '94. The total incremental OBD is used to calculate the Ancillary Services and Administrative Overhead expense in the fourth area, the cash flow analysis. A detailed discussion of each of these four spreadsheet areas follows. The spreadsheet cell references and cell formulae are presented at Appendix A.

1) Input and Output Variables

The uppermost area of the spreadsheet contains input variables for the discount rate, inflation rate, birthrate per 1000 females, and the catchment growth rate. These four variables drive the profitability analysis, the volume projection of NICU cases and recapture, and indirectly, the ancillary services and administrative overhead expenses. The clinical and ancillary

staff sections use the input quantity values to calculate a total nominal salary cost by summing the product of the input quantity and the salary per full time equivalent (FTE) over the listed staff positions. This sum is reflected in the output variable section as Nominal Salary. The nominal salary figure is then propagated to the project out-years as salary expense in the cash flow analysis by indexing the nominal salary by the inflation rate.

The next tabulation in the input variable section is the average cost per discharge of the seven Level II DRGs. Notice that these values are different than those previously presented in Table 3, because they have been indexed for inflation. Recall from Table 3 that these cost data reflect a 5 year average from FY 1990 to FY 1994, and best represent nominal dollars for FY 1992, the mean of the five year period. In order to inflate the 1992 nominal dollars to 1994 levels, an average cost index of 5 percent per annum was applied. The parenthetical @TNORMAL is a reminder that the probability function used in the risk simulation is a truncated normal distribution, which restricts the range of values sampled from distribution during simulation. The formulae in cells E17, E18, E19, E20, E21, E22, and E23 (see Appendix A) reflect the arguments for DRGs 613, 614, 619, 621, 627, 628, and 630, respectively. Each argument is listed in the following format: @TNORMAL (mean, standard deviation, minimum, maximum). The means and standard deviations are those listed in Table 3. The minimum and maximum values are the lowest and

highest cost paid for any single case in that specific DRG during the five year period from FY 1990 through FY 1994 (RCMASE-OSE). Also note the (1 + F17)^2 term which uses the inflation percentage entered in cell F17 to inflate the 1992 nominal average cost for each DRG to 1994 dollars. The use of a truncated normal distribution, bounded by minimum and maximum case costs experienced over a five year period, prevents the expected CHAMPUS cost recapture, which is the major revenue stream in the cash flow, from biasing the profitability measures during the risk simulation with excessively high or low (outlier) values.

Immediately above the cost per discharge tabulation are input values for the incremental Training and Continuing Medical Education (CME) annual cost estimate for neonatal care (Badgett 1994b), the nursery's OBD for FY 1994, the MEPRS D pool costs (Ancillary Services), and the MEPRS E pool costs (Administrative Overhead) for the newborn nursery account (MEPRS 1994). These input values are used in the cash flow analysis to generate annual operating expenses, indexed for inflation, in the project's five out-years.

The output variable section provides a summary of key values generated in other areas of the spreadsheet. As previously discussed, the nominal salary cost of the incremental clinical and ancillary staff, which is determined by the input quantity of FTEs, is calculated by the formula in cell H9 (see Appendix A).

The five year volume projection tabulates the expected births, and incremental OBD during each of the project's out-years, based on input values of the catchment growth rate, births per 1000 child-bearing aged women, and formulae in lower areas of the spreadsheet. The two profitability measures NPV and IRR, which are calculated in the cash flow analysis area, are also duplicated in the output variables section. This design permits the user to change input parameters while observing the resultant effect on output values for "what if" analysis.

2) Volume Projections

The second area of the spreadsheet generates expected volume in eight DRGs: DRG 391 - normal newborns, and the seven Level II NICU DRGs. As discussed in the preceding section, Incremental Costing Procedures, these volume projections use the catchment population's proportion of child-bearing aged women to project total births. The first three rows; CATCHMENT Population, FEMALES AGE 15-44 years, and TOTAL Births, incorporate formulae which use the catchment growth rate (CGR) and birth rate per 1000 females (BR) input values to calculate total births. Embedding the triangular probability function (@TRIANG) and historical incidence rates from Table 7 into the cell formula, the simulation generates the case volume in each DRG based on the total births value.

An examination of the cell formulae for cells D34, E34, F34, G34, H34, and I34 in Appendix A, page 116, reflects the actual catchment population of 130,304 as the entry for cell D34. In cell E34, which represents the catchment population for FY '96, note that the FY 1994 population (D34) is reduced by 8,315. This reduction reflects the net estimate of soldiers and family members lost to the catchment population due to force restructuring decisions discussed in the introductory chapter. The net population change (130,304 - 8315 = 121,989) is then indexed by the catchment growth rate in the form of an embedded unit normal probability function. The term (1+@NORMAL(C12,0.005) takes the catchment growth rate percentage entered in cell C12 of 2 percent and samples a growth rate percentage from a normal distribution with a mean of 2 percent and a standard deviation of one half percent during risk simulation. The value in cell E34 is 124,429 which reflects a 102% increase over the net catchment population of 121,989, e.g. 121,989 X 1.02 = 124,429. The remaining out-years' population projections (F34, G34, H34, I34) are simple propagation of each preceding year's projection times the sampled catchment growth rate.

In order to determine the number of females, aged 15 to 44 years in each out year's catchment population projection, a simple proportion formula was developed from Table 5 data. The age breakdown of the female portion of the total catchment population reflected that 29,750 women of the 63,365 in the

catchment were 15 through 44 years old, or 46.95% of the total. An examination of the formulae for cells E35, F35, G35, H35, and I35 in Appendix A, reveals that they use the ratio of females aged 15 to 44 years (D35) to total catchment population (D34) from FY 1994 to project the concordant value for each out-year. The formula for females aged 15 to 44 in each out-year simply multiplies this FY 1994 ratio by the projected catchment population for each out-year to generate the child bearing aged female segment.

The next row of the spreadsheet calculates the projected number of births by multiplying the input value for birth rate per 1000 females by the child-bearing aged female population calculated for each of the project's five out-years. These formulae are presented in cells E35, F35, G35, H35, and I35 of Appendix A.

The next subdivision of the Volume Projection area generates the number of cases for 8 DRGs over the project's out-years using the historical incidence rate for each DRG from Table 7 and the triangular probability distribution (@TRIANG) during simulation. The cell formulae in the range E39..I46 are mathematically equivalent in function. They multiply each project out-year's total births by the sampled incidence rate for each DRG. The probability distribution @TRIANG consists of three points: a minimum value, a most likely value, and a maximum value. The argument of the function takes the form: @TRIANG (minimum,

most likely, maximum). An examination of the formulae in cells C39, C40, C41, C42, C43, C44, C45, and C46 reflect the triangular function for DRGs 391, 613, 614, 619, 621, 627, 627, and 630, respectively. A row-wise examination of the five, out-year cells for any one DRG, i.e. E39..I39, E40..I40, E41..I41, reflect the product of the DRG's incidence multiplied by the projected total births for that out-year's column.

The last row in this subdivision calculates the columnar totals using the @SUM function and reflects a unique summary statistic. Note that the eight neonatal DRGs listed, typically account for 96% of the volume over all the neonatal DRGs. Compare the total births figure with its corresponding Routine and Level II column total in each of the project out-years.

The projected case volume in each DRG is used in the cash flow analysis section to generate the incremental case volume and expected CHAMPUS recapture which is relevant to the proposed Level II NICU. This concludes the discussion of the volume projection are of the spreadsheet model. The next section uses these DRG volume projections to determine incremental occupied bed days in the NICU.

3) Incremental Occupied Bed Days

The main purpose of this area of the spreadsheet was to determine incremental OBD in the nursery with the addition of the Level II NICU recaptured case volume as a means to allocate MEPRS

cost pools for ancillary services and administrative overhead. Listed in parentheses after each of the Level II neonatal DRGs in Table 11, is the baseline quantity of OBD in the MTF nurseries at EACH and USAFA. The second column contains the average length of stay (ALOS) values for each DRG. The cell formulae contain the @RISK probability function @NORMAL and incorporates the length of stay statistics from Table 10 to generate an ALOS for each DRG during risk simulation. The value displayed for each of these cells (C52..C58) in Table 11 is the expected value of the normal probability distribution for each DRG, given the mean and standard deviation specified in the argument of the @NORMAL function. A comparison of Table 10 and Table 11 values reveal that the expected value is the average length of stay for each DRG. However, during the risk analysis, the values returned vary with each iteration. The third column with the caption, "NAS OBD" reflects the number of occupied bed days purchased for Level II neonates with a CHAMPUS non-availability statement in FY 1994 for each DRG. This data is provided as a means to cross check the simulation generated incremental OBD values in the out-years.

The OBD values reflected by DRG in the project's five out-years are incremental OBD, based on the case volume per DRG generated in the Volume Projection area of the spreadsheet. The cell formulae at Appendix A in the cell range E40..I46 reveal the procedure to calculate the incremental OBD, which was developed in the Incremental Costing discussion of this chapter.

Essentially, each formula retrieves the number of cases generated from the appropriate volume projection cell by DRG and multiplies that volume by the ALOS value returned by the simulation. This product determines the total number of OBD in that out-year for each of the seven DRGs. The second step of the formula is to remove the DRG specific number of OBD which were provided in the MTFs during FY 1994. Thus, the value displayed in each cell is an expected number of incremental OBD recapture.

The last row of the OBD area of the spreadsheet calculates the total number of incremental OBD across the seven neonatal DRGs for each of the out-years. The increase in OBD by recapturing all the cases in these seven DRGs is roughly 350 to 400 OBD. This figure equates to one NICU bassinet's availability over a one year period, e.g. 365 OBD. To maintain a relative perspective, EACH nursery provided 2610 OBD of nursery care in FY 1994 of which 987 OBD were utilized by neonates in the seven DRGs under study (RCMAS-OSE 1994). As pregnancy and delivery display marked seasonality trends and neonates who require NICU medical treatment have increased lengths of stay, the incremental OBD figure will operationally require more than the additional capacity of one or two NICU bassinets.

4) Cash Flow Analysis

The final area of the spreadsheet model is the cash flow analysis for the Level II NICU project. The first column provides

the nine categories of relevant cash flow for the Level II NICU project evaluation. The analysis is for a six year project life, with each column representing a project year. Project year zero, FY 1995, reflects the start-up costs for biomedical equipment and nursery renovations. Notice these figures represent a total cash out-flow of $393,807. The incremental biomedical equipment cost was previously developed in Table 8, while the renovation cost was an expert estimate by the facility engineer. Using discounted cash flow analysis to bring the out-year's future cash values back to present value dollars nominal to 1995, the profitability of the project is dependent on generating sufficient net positive cash flow over the life of the project to pay back the start-up costs.

The project has two sources of cash in-flow, which are treated as revenue although they actually represent operating cost avoidance. The first source is CHAMPUS recapture, the cost avoidance of spending CHAMPUS dollars for Level II NICU care which would now be retained within the MTF. The second source is supplemental care cost avoidance for neonatal ambulance transport, which would no longer be required for those Level II neonates retained within the MTF.

To determine the incremental annual cost avoidance for Level II NICU care, the case volume for each of the seven neonatal DRGs less the number of cases treated in the MTF during FY 1994 was calculated by spreadsheet formula. These formulae appear in cells

E67, F67, G67, H67, and I67 of Appendix C. The incremental case volume for each DRG is then multiplied by the appropriate average cost value sampled from the truncated normal probability function in cells E17..E23 during the risk simulation. The total of each of these products is summated over the seven DRGs and indexed for inflation by the appropriate $(1 + i)^{PY}$ term using the inflation rate entered in cell C10 and the project year in the cell range E63..I63.

The supplemental care recapture values entered in cells E68, F68, G68, H68, and I68 are based on the neonatal transport cost experience for FY 1994. An examination of the formulae for these cells in Appendix C reveals a simple propagation of the $45,473 FY 1994 cost using the inflationary term $(1 + i)^{PY}$.

The next row, labeled "Net Cost Avoidance," simply adds the CHAMPUS and Supplemental Care recapture values calculated for each project year to determine the net cost avoidance. This formula, using the @SUM function, appears in cells E69..I69.

The next four rows generate the incremental annual operating expenses incurred by the Level II NICU based on the staff salary, continuing medical education, ancillary services and administrative overhead.

The staff salary values for the project's five out-years are calculated by indexing the nominal salary value from cell H9 in the output variables section by the inflation percentage entered

in cell C10 from the input variables section. These formulae appear in the cell range E70..I70 of Appendix A.

The annual cost of Training/CME for the incremental Level II NICU staffing was estimated at $20,000 by expert opinion (Badgett 1994c). The formulae entered in cells E71..I71 in Appendix A reflect the propagation of this point estimate, entered in cell E9 of the input variables, over the project out-years by indexing the cost with the inflation rate appropriate to that particular out-year.

The final two annual operating cost categories, ancillary services and administrative overhead, are calculated by cell formulae which are based on MEPRS cost apportionment based on incremental occupied bed days. Recall from previous discussion of incremental costing procedures in this chapter, that the incremental occupied bed days, calculated by simulation of ALOS with a normal probability distribution, were multiplied by the FY 1994 cost per OBD in the MEPRS D and E cost pools. These values are input variables in cells E10, E11, E12 at the top of the spreadsheet.

The cell formulae entered in the cell range E72..I72 in Appendix C, reflect the allocation of FY 1994 MEPRS D pool costs per OBD ($E$11/$E$10) to the sum of the incremental OBD generated for each project out-year in the cell range E60..I60. This portion of the cell formula determines the nominal cost of ancillary services as the product of the cost per nursery OBD

multiplied by the total number of incremental OBD generated over the seven neonatal DRGs by risk simulation. This product is then indexed for inflation using the inflation rate in cell C10 and the $(1 + i)^{PY}$ term appropriate to the project out-year.

The annual cost of administrative overhead for the Level II NICU is also allocated in the same manner, except that the MEPRS E pool cost per OBD in the nursery is used in the cell formulae as opposed to the MEPRS D pool cost ($E$12/$E$10). The cell formulae to calculate the administrative overhead expense for each project out-year are provided in the cell range E73..I73 of Appendix C. These formulae are also indexed for annual inflation in the same manner, based on the inflation rate entered in cell C10.

The next row of the cash flow analysis, labelled "Net Cash Flow," calculates the excess of revenues over expenses by subtracting the sum of the annual operating expenses from the annual cost avoidance. These formulae appear in the cell range E75..I75 of Appendix A. Note that project year zero only has start up costs for biomedical equipment and the nursery renovation and represent a loss of $393,807.

The last two rows of the spreadsheet use the net cash flow over the six project years to calculate the profitability of the project. The net present value calculation uses the Lotus 123 @NPV function in cell D77. The arguments for this function are the discount rate, entered in the input variable cell C9 and the

revenue stream in the cell range D75..I75. Note that this calculation includes project year zero with a net loss and the five operational years. The second function used to assess the project's profitability is internal rate of return (IRR). Using the @IRR function in cell D79 and the arguments of a point estimate of 6 percent and the cash flow in the cell range D75..I75, the spreadsheet formula calculated an IRR of 7.45 percent in Table 11.

In summary, the spreadsheet is constructed in sequential fashion with the upper areas providing input data for the lower areas until enough data is available to complete the cash flow analysis and profitability assessment. The spreadsheet displayed in Table 11 is a snap shot of one possible combination of input variables. By changing the input variables systematically, a sensitivity analysis for scenario or "what if" analysis is possible, but the spreadsheet will only calculate a point estimate of profitability. The probability functions of @NORMAL, @TNORMAL, and @TRAING built in to the spreadsheet for OBD, average cost per discharge, DRG incidence rate, and catchment population estimates are not activated and return only their expected value, i.e. the mean value of each probability distribution, without running the risk simulation. As such, the point estimates of profitability are valuable, but economic parameters, human fertility and reproduction, and delivery outcome are dynamic events. A point estimate of profitability for

a project which involves high process variability is suboptimal when compared to a simulation model. The simulation provides the ability to more realistically represent the variable nature of health care processes and their underlying biologic determinants. In the next section, the use of risk analysis simulation which was built into the spreadsheet using @RISK with Lotus 123 is discussed. The simulation is merely a tool which further enhances the spreadsheet cash flow analysis to evaluate the profitability of the Level II NICU project over a range of possibilities.

D. Risk Analysis Simulation

@RISK is an add-in simulation program available for several spreadsheet application programs. The add-in application program allows the user to embed 29 different probability distributions, such as normal, exponential, binomial, logarithmic, Pareto, Poisson, and Weibull, into spreadsheet cell formulae as @ functions. Each probability distribution's @ function has a characteristic argument which uses descriptive statistics (mean, standard deviation, standard error) to change the kurtosis and skewness of the function's probability distribution. In this manner, the probability distributions can generate a cell value for a spreadsheet variable, which varies in a manner described by one of these 29 probability distribution's density functions.

Through the use of iterative sampling, the simulation will draw values from the probability distributions specified by the @

functions placed in the spreadsheet, calculate the spreadsheet on the basis of the returned sample value(s), and retain the results of each iteration's recalculation in user specified output cells. The simulation can then construct graphic and statistical reports for user-selected output variables in the spreadsheet. The user can control the number of iterations the simulation recalculates and then records, and the type of sampling method the simulation executes: Monte Carlo or Latin Hypercubic. Other @functions permit the user to systematically vary key input parameters for the conduct of sensitivity analyses and "what if" simulations.

With regard to the spreadsheet presented in Table 10 for the Level II project evaluation, the key input parameters were the annual inflation rate, the annual discount rate, the catchment growth rate and the birth rate per 1000 child-bearing women. The key output parameters were the profitability assessments of NPV and IRR from the cash flow analysis at the bottom of the spreadsheet model. The simulation samples data points for four embedded probability distributions embedded in the spreadsheet and returns a value for each iteration in the simulation.

Recall from preceding discussion that the average cost per discharge is a simulated variable using a truncated normal probability distribution for each DRG under study. Each DRG's incidence rate is a simulation variable using a triangular probability distribution, and each DRG's length of stay is a simulated variable using the normal probability distribution. The fourth probability function is embedded in the formulae which

generate the out-years' catchment population; however the effect is to vary the catchment growth rate input variable from a fixed percentage. An examination of the formulae in the cell range E34..I34 at Appendix A reveals a term which indexes the previous year's catchment population by the quantity:

(1 + @NORMAL(C12,0.005))

This quantity takes the catchment growth rate entered in cell C12 and uses that value as the mean of a normal distribution with a standard deviation of one-half a percent. If the value input for cell C12 was two percent (0.02), the value returned for this quantity would vary between 1.005 and 1.035 at the 99% confidence level. This term introduces variability into the value generated for the catchment population, as opposed to growing the population at a fixed percentage rate. This concept is not the author's, but was suggested as an enhancement for creating uncertainty by the @RISK user's manual.

Once the spreadsheet model was constructed with the embedded probability @functions, all that remained was to run the simulation using a systematic method to control the input variables and record the results. In order to execute a simulation in @RISK, the user must specify the number of iterations and the sampling method. The available choice of sampling techniques is Monte Carlo or Latin Hypercubic.

Monte Carlo sampling is based on random number generation, and samples are more likely to be drawn from the center of the

cumulative probability distribution, which have the highest frequency of occurrence. This effect is known as clustering and becomes most critical when a low number of samples are drawn. The effect of clustering will concentrate the return values sampled about the area of the probability function with the highest probability. In effect, Monte Carlo sampling, especially with a low number of trials (iterations), will tend to exclude extreme values from the probability distribution, which may critically affect the analysis.

Latin Hypercubic sampling relies on stratification of the sampled cumulative distribution and forces the simulation to take values in systematic fashion from each stratum. The result is a sampling method which samples a wider range of values from both the center and ends (tails) of the probability distribution and returns the full range of the probability distribution in a lower number of iterations.

In order to compromise between the best attributes of both sampling techniques, the simulation was executed with Latin Hypercubic sampling, using a high number of iterations. The number of iterations was set at 2,000.

A final issue was a systematic method to co-vary the four key input variables of catchment growth rate, birthrate per 1000 child-bearing aged women, inflation rate, and discount rate and the range of values to use for each input variable in the simulation. The catchment growth rate during the baseline period

of FY 1990 to FY 1995 has averaged 2.0%, therefore, four input values of .005, .010, .015, and .02 were selected for analysis. The birth rate per 1000 child-bearing aged women from Table 6 during the baseline period ranged from 79 to 84 births, therefore four input values of 81, 82, 83 and 84 births per 1000 were selected for analysis. The annual rate of inflation was recently estimated at 3.0% by the Federal Reserve Board on July 11, 1995, with speculation of a decrease to 2.5% by year's end in December. Four input values of 2.5%, 3.0%, 3.5 % and 4.0% were selected for the analysis. The final input parameter, the discount rate, was set by the Department of Defense, indexed for project life. A discount rate of 4.5% was established for projects of four to six years' duration with a top rate of 4.8% for projects of 9 to 20 years' duration. Four discount rates of 4.0%, 4.5%, 5.0% and 5.5% were selected for the analysis.

Note that the range of values selected for each input parameter was chosen within reasonable limits, established by experience or expert opinion. Additionally, the values selected were chosen from a conservative perspective: higher discount rates, higher inflation rates, and lower catchment growth rates than indicated.

With four values for each of the four input variables, a variable array of 256 simulations was executed using a Zenith 80486 DX microcomputer running with a math co-processor. The simulations of 2000 iterations were processed four at a time by

using the @RISK's @SIMTABLE function. Holding the inflation rate, the catchment growth rate, and birth rate per 1000 fixed and allowing the @SIMTABLE command in cell C9 to change the input values for the discount rate every 2000 iterations, the processor completed four, uninterrupted simulations (8000 iterations) every six minutes. Each of these simulation batch blocks of four analyses were saved in 64 separate files on the hard drive. Following archival of each simulation's results, the other three input values were manually input and the next simulation of 4 X 2000 was started, progressing through all 256 possible combinations of the input variables. The total processing time was approximately seven hours to complete a total of 512,000 iterations and record the results.

In summary, the use of risk analysis via the repetitive sampling of the underlying probability distributions of uncertain parameters is a significant enhancement in spreadsheet financial analysis. Instead of a point estimate of key input or output variables, such as catchment population, number of infants with a DRG 630 diagnosis, net present value and internal rate of return, the simulation varies the inputs and returns a range of outcomes with their associated probability. The spreadsheet combined with the risk analysis simulation is a decision support system, whose design flexibility assures long term utility for future NICU project evaluations. New input values, staff combinations, and constraints can be continuously modified, evaluated, and reported

until the executive decision maker is confident enough with the analysis to establish decision criteria and make the decision.

This concludes the section on risk simulation and completes the financial (quantitative) analysis methodology. The sensitivity analysis of the risk simulation and selected graphic reports are presented in the third chapter, Results. The next section presents the benefit assessment (qualitative) methodology for the Level II NICU project evaluation.

E. Benefit Analysis

Throughout the financial management literature regarding financial analysis and capital budgeting, there exists a common warning: never base a capital budgeting decision strictly on quantitative assessment methods. Non-economic factors such as community need, patient satisfaction, and physician satisfaction may outweigh strict financial considerations, especially in the not for profit sector (Gapenski 1993, 416). In this section, the methodology used to assess the qualitative issues surrounding the availability of a Level II NICU at EACH are presented.

In his 1980 text, The Definition of Quality and Approaches to Its Assessment, Avedis Donabedian presents a paradigm of quality assessment for health care organizations. For Donabedian, the quality of a particular health care encounter may

be assessed at four levels:

1) Care by Practitioners and other Technical Providers
2) Amenities (convenience, privacy, comfort)
3) Care Implemented by Patient and Family
4) Care received by the Community

Donabedian arranges these four levels of assessment in hierarchical fashion in the schema of a bull's eye target of four concentric circles. Care by Practitioners and other Technical Providers forms the center of the target , with the other three levels radiating outward in concentric circular regions to the fourth level, Care received by the Community.

Using Donabedian's paradigm of quality assessment and the traditional health care service delivery tradeoff issues of cost, quality, and access to care; sixteen issues were identified for qualitative analysis with regard to the NICU services in Colorado Springs. These 16 issues are listed below:

1) Continuity of care
2) Risk management liability
3) Neonatal transport costs
4) Local market for neonatal health care providers
5) Appropriate utilization management
6) Access to care for all categories of DOD beneficiaries
7) Technology of biomedical equipment
8) Soldier's out-of-pocket cost for NICU care
9) Amenities
10) Social services support of the neonate's family
11) Positive clinical outcome of neonatal care
12) Impact of health care inflation in the local market
13) Impact of project on CHAMPUS funds
14) Impact of project on TRICARE initiatives and policies
15) Publicity and patient education
16) Effectiveness of prematurity prevention programs

With the sixteen qualitative elements identified for benefit analysis, a procedural method to conduct the analysis was suggested by the author's faculty advisor utilizing the Judging Utility: A Decision Generator and Evaluator (JUDGE) model presented during graduate course work on Research Methods (Finstuen 1994) in the didactic phase of instruction.

The JUDGE model is a quantitative method of alternative evaluation based on the specification of alternative attributes and the differentiation of alternatives by attribute ratings. The JUDGE method consists of an eight step process as follows:

1) Specify attributes of the alternatives
2) Make attribute ratings using a 9 point scale
3) Recode and Rescale attribute ratings
4) Identify alternatives
5) Write the alternative equations in linear form
6) Judge the utility of the alternatives
7) Compute alternative decision indices
8) Evaluate decision alternatives

Utilizing the sixteen quality issues as the attributes of the Level II NICU project alternatives of Make or Buy, a survey instrument was constructed with the assistance of the Total Quality Management Coordinator (Pollock 1995) and a commercial software program (SurveyPRO). A sample of the survey instrument is provided at Appendix B on page 122.

The survey instrument is designed to facilitate application of the JUDGE model's eight step process and consists of two parts. Part one asks respondents to rate the importance of sixteen attributes concerning the provision of neonatal intensive care services in Colorado Springs on a nine point, adjective-

anchored scale. Part two presents the respondent with a 'make' scenario for a Level II NICU at EACH as one alternative and a 'buy' option using CHAMPUS funds to purchase Level II NICU services from Memorial hospital as the second alternative. The respondent is then asked to apportion 100 percentage points between the two available alternatives, based on their opinion of how well each alternative satisfies the specified attribute.

For this study, the respondents consisted of a Delphi panel of six subject matter experts: LTC Dai, the chief of pediatric services; LTC Jones, the chief of obstetric services; LTC Cefaly, obstetric nurse; LTC Kephardt, pediatric nurse practitioner, COL Leisher, the deputy commander for administrative services, and MAJ Bracey, the inpatient administrator. This Delphi panel of respondents were asked to complete the survey instrument on Level II NICU services as experts in the physician, nursing, and health care administration fields. Each respondent's survey was manually scored and the results were tabulated separately in a Lotus 123 spreadsheet.

Next, the eight step JUDGE process was applied to evaluate the benefits of the make or buy alternatives. Step one, specify attributes of the alternatives, was accomplished with the construction of the survey instrument using the sixteen NICU service issues. Step two, make attribute ratings using a nine point scale, was accomplished by the Delphi panel members in their survey responses. In order to simplify the calculations involved in the remaining six steps, a spreadsheet was constructed

and added to the tabulation of the survey responses. Table 12, on the following page provides the JUDGE model spreadsheet and becomes the focus for the remaining discussion of the method.

The first column lists the sixteen attributes identified in step one. The second column reflects the average value of the Delphi panel's responses to each attribute on the nine point scale and completes step two. Step three, Recode and Rescale the Attribute ratings, is accomplished in the third column labelled, "CODE X-FORM." The formulae in these cells recode the ratings on the nine point scale by subtracting the integer 5 from the average score for each attribute. This recoding transformation changes the original nine point scaling, with a neutral point of five, to a nine point scale with a neutral point of zero. The transformed values, which may now range from -4 through 0 to +4, provide a scaling value which indicates both magnitude and direction for the attribute. The sum of the recoded attribute scores becomes the divisor to determine the scaling factor used to subdivide the whole of the decision space. The scaling factor is calculated by a spreadsheet formula which divides the total of the recoded ratings (42.333) into one, the unity value for the whole of the decision space. The resulting dividend of 2.3622 becomes the scaling factor for the decision space. The scaling factor is multiplied by each recoded attribute score to differentiate the decision space, and this product is listed in the fourth column as the rescaled ratings. Note that each

TABLE 12

JUDGE Model for Level II NICU Alternatives

				VALENCE	Utility Weight		Weighted Composite	
	ATTRIBUTE ITEMS	9 POINT SCALE	CODE X-FORM	Rescaled Ratings	Alt. A EACH	Alt. B MEMORIAL	Alt A	Alt B
1	Continuity of Care	8.83	3.83	9.0551	0.4317	0.5683	3.9088	5.1463
2	Risk Management	6.83	1.83	4.3307	0.3750	0.6250	1.6240	2.7067
3	Transport Svc Costs	8.17	3.17	7.4803	0.9500	0.0500	7.1063	0.3740
4	Provider Market	7.67	2.67	6.2992	0.3333	0.6667	2.0997	4.1995
5	Approp. Utilization	8.17	3.17	7.4803	0.3417	0.6583	2.5558	4.9245
6	Access to DOD Benefic.	8.67	3.67	8.6614	0.5333	0.4667	4.6194	4.0420
7	Technology of Biomed	8.00	3.00	7.0866	0.5250	0.4750	3.7205	3.3661
8	Out-of-Pocket Cost	7.83	2.83	6.6929	0.7667	0.2333	5.1312	1.5617
9	Amenities	6.50	1.50	3.5433	0.5083	0.4917	1.8012	1.7421
10	Social Services	7.50	2.50	5.9055	0.5083	0.4917	3.0020	2.9035
11	Clinical Outcome	8.83	3.83	9.0551	0.5167	0.4833	4.6785	4.3766
12	HC Inflation	7.50	2.50	5.9055	0.8500	0.1500	5.0197	0.8858
13	CHAMPUS & Mission Funds	7.17	2.17	5.1181	0.8833	0.1167	4.5210	0.5971
14	TRICARE Bid Price Adj.	6.00	1.00	2.3622	0.7833	0.2167	1.8504	0.5118
15	Publicity & Pt. Educat.	7.00	2.00	4.7244	0.4250	0.5750	2.0079	2.7165
16	Prematurity Prevention	7.67	2.67	6.2992	0.3917	0.6083	2.4672	3.8320
N=16	COLUMN TOTALS:		42.3333	100.0000			56.1135	43.8865

SCALING FACTOR: 2.3622

rescaled rating may have a positive or negative value, or valence, which contributes to or detracts from the unity of the decision space. As a means to check computational accuracy, the sum of all the rescaled ratings must total 100 percent to represent the entirety of the decision space. The sum of the rescaled ratings in Table 10 reflects 100 percent, which indicates that the spreadsheet formulas entered by the author to this point are correct.

The fourth step, identify alternatives, is accomplished in Part two of the survey at Appendix B. The first alternative comprises the Level II NICU at EACH, or the make option. The second alternative is the buy option, using the NICU services at Memorial Hospital.

Step five, write the alternative equations in linear form, requires that each alternative be quantitatively expressed as a linear equation which reflects the summation of the sixteen attribute valences. To further differentiate the decision space, each attribute is assigned a utility weight, which reflects the respective alternative's differential contribution of utility to each attribute. These weights, determined by the respondent's apportionment of 100 points between alternatives, become the coefficients of utility for each of the alternatives' sixteen attribute valences. Thus, the linear equations reflect a summation of products over the 16 attributes of each alternative's utility coefficient times the valence (rescaled ratings) for each attribute.

Algebraically, the linear equations for the two alternatives take the following form:

Alt A: $Y_1 = ({}_1w_1 * V_1) + ({}_1w_2 * V_2) + \ . \ . \ . + ({}_1w_{16} * V_{16})$

Alt B: $Y_2 = ({}_2w_1 * V_1) + ({}_2w_2 * V_2) + \ . \ . \ . + ({}_2w_{16} * V_{16})$

Where ${}_iw_j$ indicates the utility weight of alternative i for the jTH attribute, and V_j equals the valence of the jTH attribute

The sixth step, judge the utility of the alternatives, is accomplished in part two of the survey. To determine the utility weights for the make option, Alternative A (EACH) and the buy option, Alternative B (MEMORIAL), respondents were asked to apportion 100 points between the two alternatives, according to how well each alternative fulfilled each of the sixteen attributes. Therefore, the utility weights reflect a probability of attribute attainment by each alternative, such that the sum of the subjective probabilities assigned for each attribute equals one, e.g. 0/100, 25/75, 33/67, 50/50, 67/33, 80/20, etc. The average of the utility weights assigned to each attribute by the Delphi panel are presented in the fifth and sixth columns of Table 12, labelled "Utility Weights."

The seventh step of the JUDGE model process, compute alterative decision indices, uses the linear equations presented above to calculate a weighted composite value for all sixteen attributes. This value is the product of each alternatives' utility weight, tabulated in columns five and six of Table 12, times that attribute's valence. The Weighted Composite total

score is the sum of each alternative's 16 attribute composite values. The values calculated by the spreadsheet are 56.1135 for Alternative A (make) and 43.8865 for Alternative B (buy). Note that the sum of these two values is 100 percent.

The final step, evaluate decision alternatives, embodies the concept of a sensitivity analysis using the top three and bottom three attributes, as determined by weighted composite value, for each alternative. The top three attributes for the Make alternative are neonatal transportation service costs (7.1063), soldier's out-of-pocket cost (5.1312), and impact of health care inflation on the local market (5.0197). The bottom three attributes for the Make alternative are risk management liability (1.6240), amenities (1.8012), and TRICARE bid price adjustment (1.8504). The top three attributes for the Buy alternative are continuity of care (5.1463), appropriate utilization management (4.9245), and positive clinical outcome of neonatal care (4.3766). The bottom three attributes are neonatal transportation service costs (0.3740), TRICARE bid price adjustment (0.5118), and impact on CHAMPUS and mission funds (0.5971).

It is necessary to consider the lowest composite scores as the decision between alternatives may be driven by attributes with negative valences, such as risk management liability in the Make alternative. If the attributes position in the top three/ bottom three analysis by alternative are intuitively appropriate,

the JUDGE model and the respondents have discriminated the most critical attributes between the two alternatives. Had this not been the case, some tradeoffs between alternatives must be evaluated to select one alternative over the other.

In summary, the JUDGE model provides a method to evaluate the benefits of the two alternatives, based on the subjective evaluation of health care delivery and quality issues inherent to both. The Delphi panel provided a means to increase objectivity of the assessment and gain an eclectic viewpoint devoid of special interest agendas.

With a detailed description of the methodology and procedures necessary to conduct the six steps in the capital budgeting model introduced at the opening of this chapter completed, the remaining three chapters flow in logical sequence: Results, Discussion, Conclusions and recommendations. Chapter two has documented the cash flow identification, financial analysis, benefit analysis and benefit evaluation techniques used in this study. The next chapter presents the results generated by these analytic methods.

CHAPTER 3

RESULTS

A. Results of Financial Analysis by Risk Simulation

The results of the cash flow analysis conducted by risk simulation using the spreadsheet model are presented at Appendix C on page 127. Appendix C consists of four separate tables, based on the four inflation rates selected for the risk simulation. Within each two page table, the profitability measures for mean NPV and mean IRR are systematically tabulated by the remaining three input variables: first, by catchment growth rate; second, by birth rate per 1000 child-bearing women; and third, by discount rate.

The major subdivisions in each inflation rate table have a constant input value for the catchment growth rate, e.g. 0.5%, 1.0%, 1.5%, and 2.0 %, while the births per 1000 input value (81, 82, 83, and 84) increases within each block of four data points. Recall from the previous chapter that each row-wise entry in the table reflects the result of a simulation of 2000 iterations using Latin Hypercubic sampling of the embedded probability distributions in the spreadsheet.

The calculated data reported for each risk simulation are the profitability measures of net present value (NPV) and

internal rate of return (IRR). Note that these are the mean (expected) values obtained from the statistical report generated for each simulation. These statistics for mean NPV and mean IRR are presented along with the associated probability of obtaining a positive result, which reflects the probability of the project attaining a break even net cash flow.

The results of the 256 simulations in Appendix C range from an expected NPV of -$321K to an expected NPV of $198K. The expected IRR also displays a wide range of results, from -100.5% to -12.9%. Both the minimum and maximum profitability values returned by the simulation occur when the annual rate of inflation is set at its lowest rate, so the project is least sensitive to the annual rate of inflation.

In order to focus the analysis to key results for NPV and IRR generated by the 256 simulations over the selected range of input variables, three detailed results analyses for the best, worst, and most likely case combinations of input variables are presented using the statistical and graphic reports of the @RISK simulation software.

1) Best Case

The best case simulation resulted when the catchment growth rate (CGR) and the birth rate per 1000 (BR) were set at maximum values, 2 percent and 84 per 1000, respectively, while the annual rate of inflation (I) and the annual discount rate (R)

were set at minimum values of 2.5% and 4.0% for the simulation. Figure 3, on the following page, depicts the probability frequency distribution for net present value generated by the simulation with the input variable values as depicted. The expected NPV is $198,786 with a 61.5% probability of a positive NPV. Note the scaling of the ordinate and abscissa differ between this graph and latter figures of this chapter, which illustrate the most likely and worst case simulations. Therefore, Figure 3 is more leptokurtic than depicted due to scaling.

2) Most Likely Case

The title of this subsection requires operational definition. The intent is to present that case, which represents the most realistic values of the input variables, based on historical experience and expert opinion. In other words, that case which the author determined was most likely to occur in the future given his research experience. These values would be the input values selected for a simple point estimate of project profitability. Using values of I = 3.0%, R = 4.5%, BR = 82, and CGR = 2.0%, the simulation generated a mean NPV of $5,348 and a probability of the project attaining a break even cash flow of 48.0%. Figure 4, on page 90, depicts the NPV probability frequency distribution generated by simulation for this case. Input variable settings are reflected on the graph.

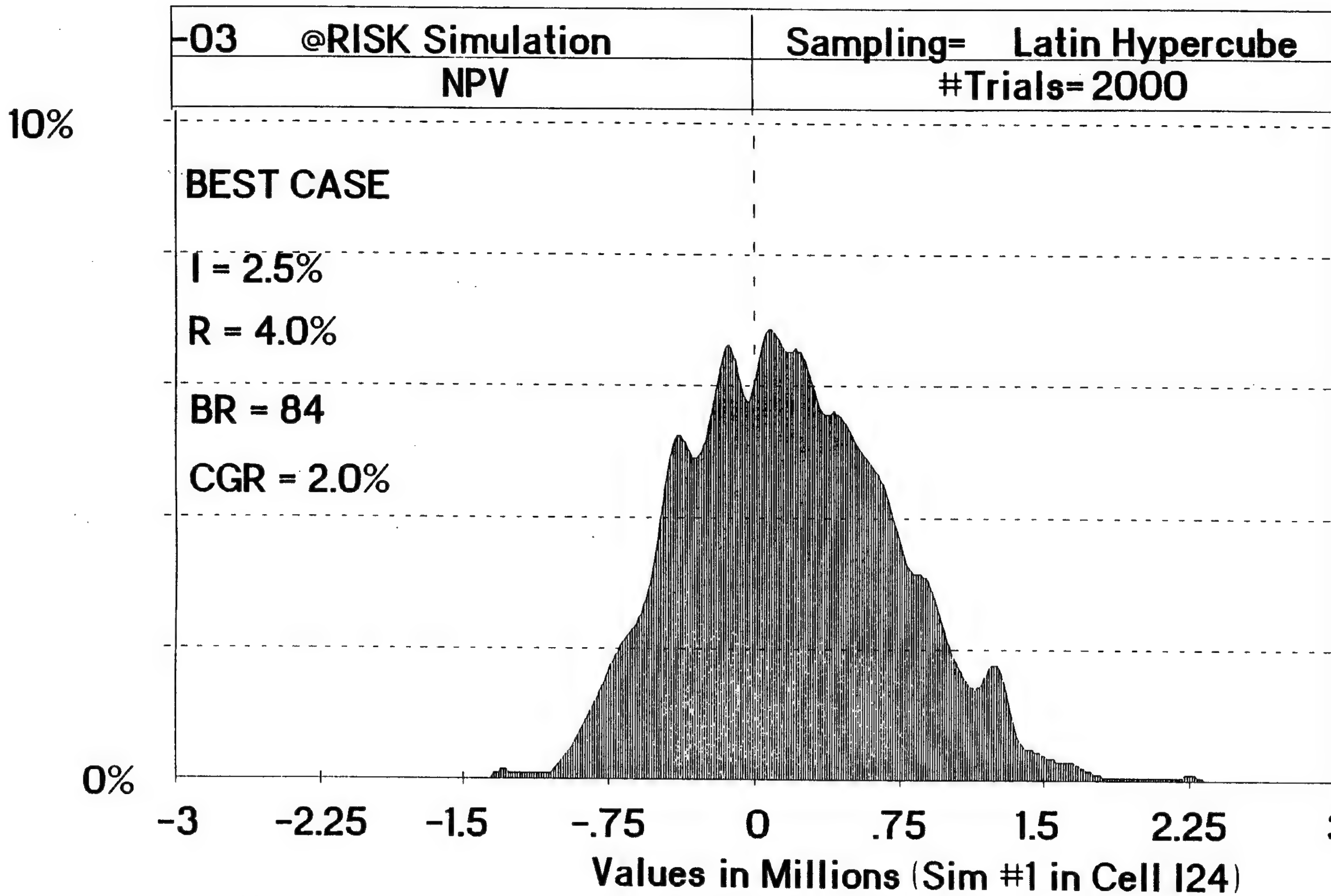

Figure 3. Probability distribution of Net Present Value under Best Case Scenario

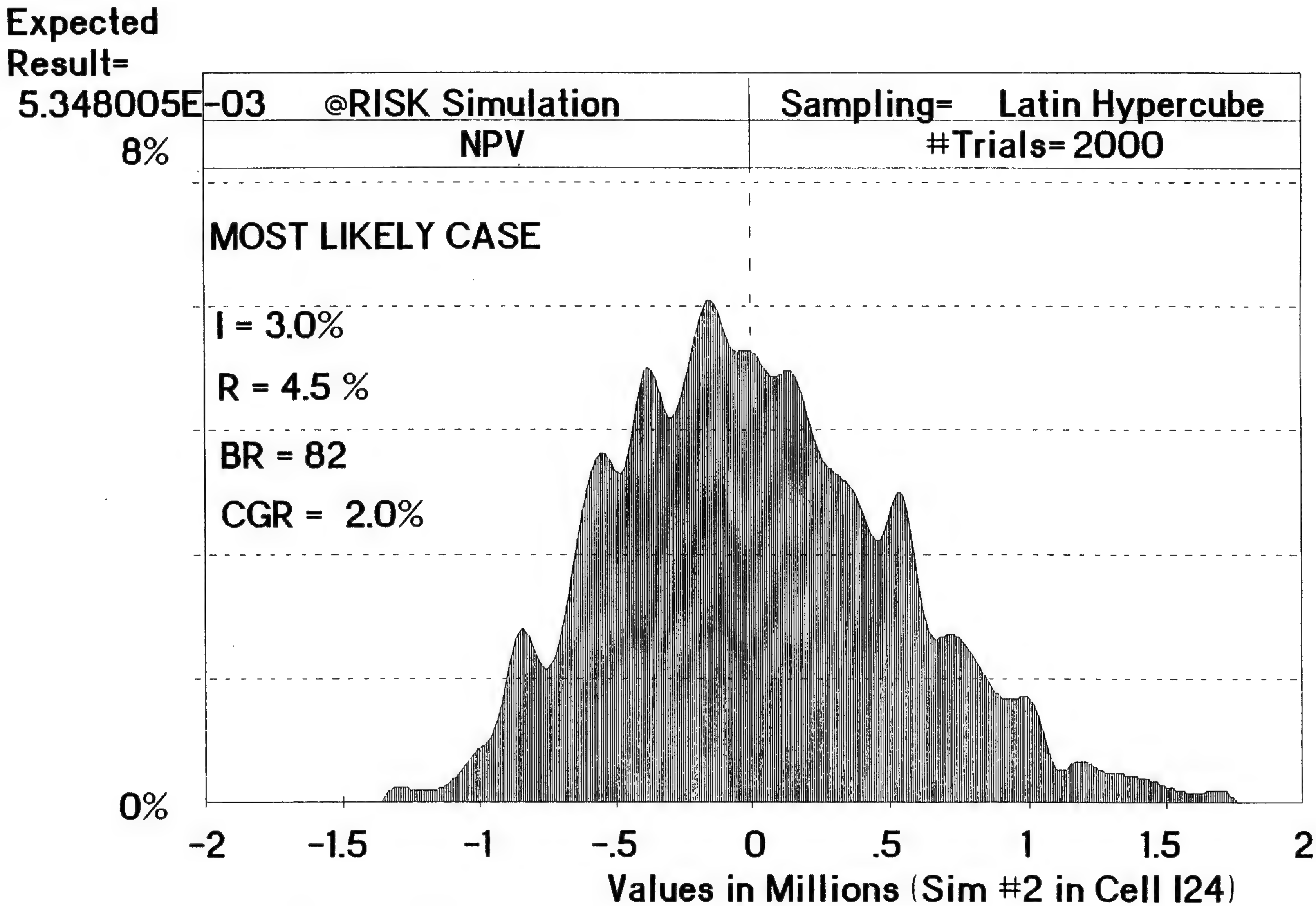

Figure 4. Probability distribution of Net Present Value under the Most Likely Case scenario.

3) Worst Case

Decision makers are frequently interested in the worst case scenario to determine the maximum liability which might occur if the project is given approval. For risk aversive decision makers it is usually the first analysis considered. For the worst case to theoretically occur, catchment growth rate and birth rates must be at minimum value while the economic indices used to inflate and discount future cash flow are set for maximum penalty.

The corresponding input values for this case, among the range of values used for the sensitivity analysis, are CGR = 0.5%, BR = 81 per 1000, I = 4.0%, and R = 5.5%. Using these input values, the simulation generated an expected NPV of -$425,014 and a probability of 19.2% of attaining break even cash flow. Figure 5, on page 93, depicts the NPV frequency distribution of probability for this case.

A careful analysis of page 134 of Appendix C for this case paradoxically reveals that more adverse profitability measures and probability of break even cash flow resulted from simulations subject to more favorable discount rates. With the input variables set at CGR = 0.5%, BR = 81 per 1000, I = 4.0%, and R = 4.0% as opposed to 5.5%, the simulation generated an expected NPV of -$443,539 and a concordant lower probability of break even cash flow of 18.8%. This result is an artifact of sampling in the simulation.

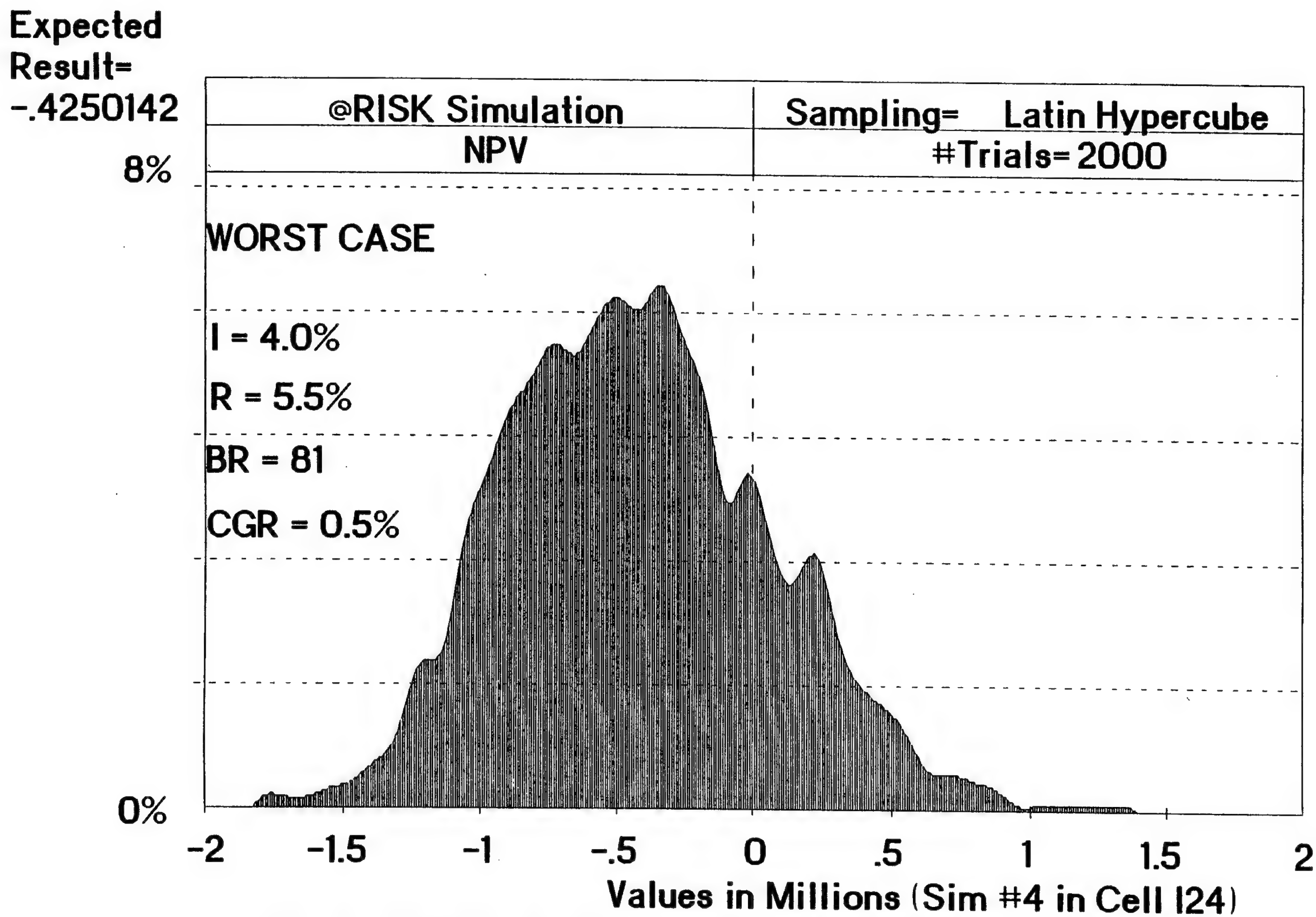

Figure 5. Probability distribution of Net Present Value under Worst Case Scenario.

Tables 13 and 14 below provide a summary listing of key statistics and the 95% confidence interval for the NPV and IRR calculated by simulation. These tables conclude the results reported for the financial analysis by risk simulation.

TABLE 13

NPV SUMMARY STATISTICS BY CASE SCENARIO

CASE SCENARIO	MEAN NPV	STD DEV	CONFIDENCE INTERVAL 5%	< X <	95%
BEST	$198,786	$548,630	-$655,755<	NPV <	$1,175,210
LIKELY	5,348	520,025	- 810,886<	NPV <	912,750
WORST	- 425,014	480,592	-1,155,300<	NPV <	386,432

Source: Simulation generated data

TABLE 14

IRR SUMMARY STATISTICS BY CASE SCENARIO

CASE SCENARIO	MEAN IRR	STD DEV	CONFIDENCE INTERVAL 5%	< X <	95%
BEST	-15.39%	73.00%	-170.89%<	IRR <	58.46%
LIKELY	-38.87%	84.97%	-177.29%<	IRR <	47.08%
WORST	-128.43%	86.80%	-190.61%<	IRR <	32.75%

Source: Simulation generated data

B. Results of Benefit Analysis by JUDGE Method

The benefit analysis of the survey on Level II NICU alternatives was evaluated by the JUDGE method presented in Chapter 2. The total of the weighted composite scores for the sixteen attributes presented in Table 12 on page 81 reflect a

score of 56.1135 for Alternative A (Make) and 43.8865 for Alternative B (Buy). These composite scores indicate that the Delphi panel collectively favors a Level II NICU at EACH over the current use of Memorial Hospital's NICU services based on the attributes considered, and a higher total score. The top three attributes in favor of the Level II NICU at EACH are all cost issues: avoidance of neonatal transport services cost, reduced out-of-pocket costs for soldiers, and the effect of health care inflation on CHAMPUS costs. However, the panel indicated that continuity of care, more appropriate utilization management, and better clinical outcomes were advantages of the buy alternative over the make decision.

In summary, the results of the financial analysis reflect that the financial feasibility of the project, based on profitability measures of NPV and IRR, is marginally positive given the most likely situational parameters. Further, the benefit assessment by a Delphi panel of physicians, nurses, and health care administrators favors the service delivery and quality attributes of the make option over the buy option, primarily due to cost avoidance issues. In Chapter 4, the discussion of the results of the study, the reader will discover why the Level II project at EACH will not be attempted.

CHAPTER 4

DISCUSSION

A. Financial Analysis

The results of the cash flow sensitivity analysis in Appendix C reflect the import of catchment population growth and birth rate among the child-bearing aged female population to the project's financial feasibility. The project only generates a positive cash flow when the case volume in the Level II neonatal DRGs for recapture of CHAMPUS costs is sufficient to exceed and offset the high annual operating expenses required to meet certification requirements for the NICU. With the catchment growth rate set at one-half a percent (0.5%), the simulation never generated a positive cash flow for the project. The project begins to show positive profitability measures at a catchment growth rate of one and a half percent (1.5%) but only with birth rates of 83 or 84 per 1000 child-bearing aged women. With the catchment growth rate at two percent, the project will generate marginally positive profitability with birth rates as low as 82 per 1000; however, the annual rate of inflation must be less than three and one half percent or the project returns to negative profitability as annual operating expenses erode the margin.

Returning to Table 6 on page 40 for catchment demography of child-bearing aged women, the overall population growth reflected was never static or negative over the past four fiscal years. By contrast, both the catchment population and number of women aged 15 to 45 years have steadily increased. The child-bearing aged female complement has increased by an average of 1079 women per year, while the birth rate has fluctuated between a low of 79 per 1000 in FY 1993 to a high of 84 in FY 1992. Recall that 1992 was an aberrant high due to the impact of the Persian Gulf War. The most recent year's birth rate reflects 82 per 1000. The catchment growth rate has fluctuated from a low of 1.1% between FY 1990 and 1991 to a high of 3.3% between FY 1993 and 1994. Over this four year period, the CGR has averaged 2.16%

These demographics reflect an overall historic trend of catchment growth and variable birth rate within the range of marginal profitability with an annual rate of inflation below 3.5% for the project's six year life. Returning to Appendix C for some specific examples, the expected net present value of the project with CGR at 2.0%, BR at 82 per 1000, I at 3.0%, and R at 4.5% is only $5,345 with a 48% probability of break even cash flow. This scenario is the most likely case, presented in Chapter 3. If the effective annual rate of inflation averaged 2.5% over the project life, holding the other input values constant, the expected profitability for NPV rises to $33,635 with a probability of 48.7% of generating positive cash flow. However,

if the average annual rate of inflation rises to as little as 3.5%, the project's NPV goes negative to an expected value of -$24,542.

One means to bolster the project's potential profitability is to reduce fixed costs in salary expense of FTEs and contract for part time nursing based on seasonal demand. A quick review of Table 9 on page 47, reflects that 10.5 FTEs of the incremental 16 FTEs of recommended nursing staff are already employed at a reduced salary level. The main staff expenses for nursing are 3.5 new FTEs of supervisory nursing personnel to manage the higher acuity of Level II neonates on a 24 hour basis. Therefore, the incremental staff salary expenses have already been minimized by paying existing staff an increased salary to handle the increased workload and responsibility of higher acuity patients.

A second means would be to reduce the size of the unit from twelve to six NICU bassinets and save approximately $80,000 off the start up cost for biomedical equipment with a minimal reduction in renovation contract costs. This reduction equates to saving $16,000 each year off the operating expenses. The primary cash flow problem remains the level of annual operating expenses.

As reflected in Table 10 on page 55, the main barrier to project profitability is the high annual cost to operate a Level II NICU with the expectation of only recapturing 300 to 400 additional OBD in Level II case volume. Due to the limitations on Level II neonates which could be admitted to EACH, based on birth

weight, gestation, and the need for surgical intervention and ventilator support; the Level II NICU is a "lumpy" asset which lacks a large enough continuous revenue stream to capitalize given the restricted volume of admissions. A similar analogy would be buying a commuter car that you could only drive to work on fair weather days.

The finding that the Level II NICU is too capital intensive for a restricted admission policy is consistent with the economic studies in the literature reviews. The high cost of NICU salary expenses and cost shifting required to maintain financial solvency are validated by the simulation generated financial analysis in this research. As the incremental case volume is small by comparison to the asset intensive nature of a Level II NICU, a proactive strategy of prevention to further reduce the small incremental case volume is more cost efficient and effective than a strategy of renovating the existing nursery.

Two factors detract from the accuracy of the financial analysis. The first is the validity of the cost information in the MEPRS data base and the second is the inconsistency of common information across the patient databases.

The MEPRS method of cost allocation is based upon cost drivers referred to as Step down Assignment Statistics (SAS). In the cash flow analysis the annual operating expenses for ancillary services and administrative overhead were allocated on the basis of occupied bed days (OBD) in the nursery. In certain

cost pools this method is biased and tends to overstate the actual cost of neonatal care. For example, the cost of patient nutrition is allocated on the basis of occupied bed days. Although it is readily apparent that neonates are not consuming meals from the hospital dining facility during their confinement, some portion of the dining facility's operating cost is unfairly allocated to the nursery simply due to the choice of the SAS. Due to the bias inherent in step down cost finding, the MEPRS cost allocated to the nursery is overstated, which adversely influences the project's profitability.

The second weakness of the financial analysis methodology is the use of multiple patient data bases (RCMAS-OSE, DMIS, MASS) which contain conflicting data for common information such as catchment population, number of births, number of women aged 15 to 45, and discharge diagnoses. The propagation of database software and the lack of integration between different systems is disconcerting, as the researcher must find creative methods to wring the information from several sources, using a collection of data sort strategies and than assimilate these different queries by stubby pencil to glean the desired information. This process is time consuming, error prone, and frustrating. Some of the inherent error variance is compensated for by the simulation's sampling over a range of possible values; however, reliability of data is essential to the validity of the results generated.

In summary, the financial analysis has some limitations which are overcome through the use of simulation to compensate for uncertain input values. The rule of conservatism and use of realistic input values may tend to understate the profitability of the project; however, the simulation reveals only a 48% probability for positive cash flow in the most likely case scenario. The simulation's sensitivity analysis strongly documents that the limiting factor with the Level II NICU project is insufficient incremental volume to offset the start up and operating costs of the make option, unless the birth rate attains the high levels experienced following the Persian Gulf War. The project's financial feasibility is less than a fifty : fifty proposition under the most realistic conditions anticipated and is not recommended for execution. It is less risky to diminish the small incremental volume through a comprehensive prematurity risk assessment and prevention program, while continuing to buy the needed Level II and III NICU services from Memorial Hospital through CHAMPUS.

B. Benefit Analysis

The results of the benefit analysis by JUDGE model indicated that the Delphi panel of two physicians, two nurses, and two administrators favored the make alternative over the buy alternative. The top three attributes in favor of the make alternative were all related to cost issues: avoidance of

contract neonatal transport charges, reduced out-of-pocket costs to soldiers for CHAMPUS copayments and deductibles, and the impact of health care inflation on CHAMPUS costs. By contrast those attributes which were most favorable for the buy option were continuity of care, appropriate utilization management, and better clinical outcomes.

These results are consistent with the operational nuances inherent to each choice. Since Memorial hospital has monopoly power in the local market and the FAMC NICU is no longer available for regional referral, the key discriminator used by the panel of respondents for the make option is cost avoidance. For the buy option, the key discriminator is better quality of neonatal care. This finding is realistic as Memorial has Level III NICU capability and is staffed and equipped for certification at that level. Continuity of care and clinical outcome are perceived to be better at Memorial as its provides the full range of neonatology services and access to tertiary care specialists in pulmonology, cardiology, and pediatric surgery. The attribute of appropriate utilization management is probably perceived to be higher in the buy option due to the more active discharge planning and case management effort used in civilian hospitals in comparison to military facilities.

Analyzing the bottom three attributes by alternative, the quality versus cost avoidance discrimination pattern is again evident between make and buy options. The down side of the buy option alternative is neonatal transport costs, TRICARE bid price

adjustment and impact on CHAMPUS and mission funding. Once again the panel is discriminating based on cost. The continued use of Memorial Hospital is viewed as a drain on capital resources which obligates funds and minimizes alternative use options.

The downside of the make option is a mixture of cost issues and quality issues. Increased risk management liability is a cost issue predicated on poor outcomes. Amenities, the convenience privacy and comfort of the patient care setting, are perceived to be of lower quality in the MTF than the civilian facility. This attribute is a quality assessment issue from the Donabedian paradigm. The final adverse attribute is TRICARE bid price adjustment, which is a cost issue.

It is noteworthy that the TRICARE attribute is a detractor of both the make and buy option. The effects of bid price adjustment act as a penalty in the make option if EACH cannot sustain the project through the baseline period and into the contract year. In the buy option, the TRICARE contractor would get a bid price increase if utilization at Memorial were to increase substantially from the baseline period. In effect, TRICARE is perceived as a threat to both options in terms of higher contract costs dependent on utilization patterns relative to the baseline period.

In summary, the benefit analysis reflects that the make option is primarily favored as a means to avoid CHAMPUS and contract costs, reduce soldier's CHAMPUS cost share, and hedge against health care inflation in a monopoly market for NICU

services. These cost issues are more important from the panel's viewpoint than the quality issues which favor the buy option: continuity of care, clinical outcome, and appropriate utilization management. TRICARE impact is perceived as a double edged sword which has a negative effect on both the make or buy option. The next section presents a discussion of the TRICARE impact on the health care operating environment during the baseline (FY'96) and contract implementation year (FY '97) and why bid price adjustment has fostered a defender business strategy of divestiture and retrenchment.

C. Business Plan Strategy under TRICARE

During the past ten years the Catchment Area Management (CAM) project, the CHAMPUS Reform Initiative (CRI), Coordinated Care initiatives, and the health care operating environment fostered a fundamental strategy of CHAMPUS cost avoidance. The essential construct was for the military treatment facility commander to privatize high volume or high cost services through local contracts using CHAMPUS funds if it were cost effective. The concept was to recapture those services which could be performed in the MTF at a reduced cost when compared to issuing a NAS and paying the CHAMPUS allowable charge in the civilian health care market.

As a result of this strategy, several clinical product lines and patient services were added to the MTFs in Colorado Springs by using existing medical treatment facilities and equipment

while contracting for the necessary personnel to provide the staffing for these services. Evans Army Community Hospital, a test site for the CAM demonstration project, utilized this strategy to incrementally add patient services and treatment capacity through CHAMPUS partnership providers in primary and specialty care. Outpatient services to include durable medical equipment loan, home oxygen, home care, ostomy patient support, total parental nutrition and pharmacy programs were all provided under this strategy of CHAMPUS cost avoidance, with substantial CHAMPUS savings.

The Department of Defense's most recent managed care program is TRICARE, which makes provision for privatization of health care services through eight regional managed care support contracts in the continental Unites States, requires a managed care contractor to bid for a fixed price, cost adjusted contract on the basis of a request for proposal (offer). The contractor is at financial risk to provide those services specified in regional health services plans under one year contract options over a five year period.

Within the option provision for year to year renewal and cost adjustments are formulae to adjust the bid price of the one year contract on the basis of utilization patterns and resource sharing between the contractor and the military treatment facility. The contractor records a baseline year of utilization data, prior to the first contract option year, as a benchmark to adjust the contract price. If utilization patterns change

relative to the baseline year, the contract bid price can be adjusted up or down, based on the change in utilization. If the military treatment facility waits until the first year of the contract to shift patient volume to the contractor, the contractor will receive a bid price adjustment to compensate for higher than baseline utilization. TRICARE rules preclude the use of CHAMPUS partnership providers and force the local MTF to closely scrutinize the continued viability of all services offered during the baseline year. Those services which cannot be sustained through the baseline year into the contract years will serve only to increase the utilization factor in the contract year and raise the cost of the contract through bid price adjustment.

This situation, further exacerbated by personnel end strength reductions in both the military and civilian personnel authorizations and operating budget reductions, has dramatically changed the business strategy as the baseline year for TRICARE approaches in this region. At Fort Carson, the local implications of right sizing the medical force, direct care operating budget reductions, and preparations for TRICARE have mandated a strategy of retrenchment and divestiture of programs added after ten years of successful CHAMPUS recapture initiatives.

Faced with a 5 million dollar operating budget cut, a reduction of 50 man years in the civilian staff, a reduction of 14 officer authorizations, the closure of FAMC, and the start of the baseline year for TRICARE on October 1, 1995, the hospital

leadership has developed a business strategy to curtail many programs and services. The new strategy is designed to make the baseline year's utilization pattern match the first TRICARE contract year as closely as possible to minimize a bid price increase in the contract price.

This dramatic change in the health care operating environment due to TRICARE implementation and resultant strategy to divest non-sustainable services has essentially eliminated all consideration of a Level II NICU venture in Colorado Springs by EACH under the paradigm of CHAMPUS cost avoidance and recapture. The command's strategy with regard to neonatal intensive care is to allow the contractor to assess the utilization in the baseline year and make a bid based on the services plan and request for proposal.

As a result of operating environment changes, the initial conditions which prompted the study and the problem statement have diametrically changed. However, the research effort and results of the study are not without merit. The final chapter presents the conclusions and recommendations from the study which are valid and appropriate under the TRICARE business strategy.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

The financial analysis and benefit analysis of the make or buy Level II NICU project evaluation generated mixed results. The qualitative method, using a Delphi panel of respondents and a survey instrument, recommended the make alternative. However, the quantitative method of incremental cash flow analysis over a six year project life by risk simulation, resulted in negative profitability except for the most favorable scenario. Given these results and the drastic change in business strategy as a result of personnel right-sizing, budget constraints, and TRICARE implementation, the best alternative is the buy option. The make option is untenable, primarily due to the inadequate annual volume of Level II neonates and incompatibility with TRICARE business plan strategy.

The post population at Fort Carson is under a dynamic state of demographic change as units from Fort Bliss, Fort Devens, and Fort Hood relocate to Colorado. The population demographics used in the risk simulation were derived from historic database information when those demographics were far more stable. The displacement of three brigades of divisional soldiers by an armored cavalry regiment and a special forces group

is a significant change in the catchment population which will have a direct effect on the demand for obstetric health care services at Fort Carson.

Given the tempo of change in both the demography of the general operating environment and business strategy in the health care operating environment, the findings of this research project point to several recommendations for accommodating the changes anticipated between the present time and TRICARE contract implementation on October, 1, 1996 with regard to neonatal care. These recommendations encompass three areas of the health care operating environment at EACH: prenatal care, case management, and medical information systems.

The existing prematurity risk assessment and prevention program in obstetrics services should be re-evaluated and improved using empirically developed assessment methodologies and available techniques. A valid method of assessment and prevention, especially in light of dynamic catchment population demography, is the single most effective intervention to reduce volume of neonates who require NICU services. Figure 6 on the following page is a Pareto diagram of neonatal DRGs excluding normal newborns (DRG 391) for the Colorado Springs catchment during FY 1994. Note that DRGs 601, 621, 627, 628, and 630 account for 88.3% of all non-normal newborns. Of these five DRGs only DRG 601 is not a Level II NICU managed diagnosis. The remaining sixteen neonatal DRGs account for only 11.7% of the

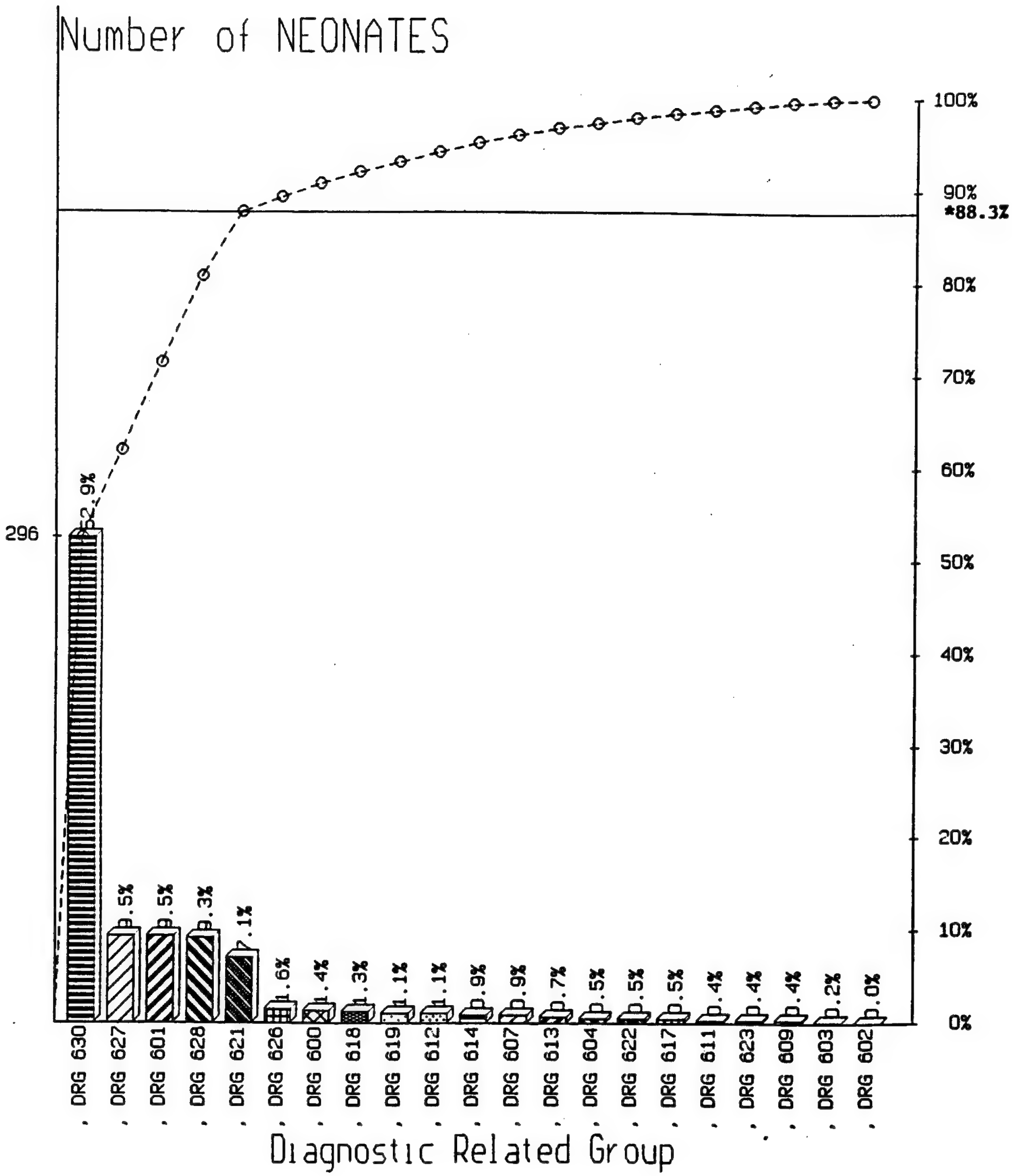

Figure 6. Pareto diagram of NICU DRGs for FY 1994.
Source: (Mantia 1995, Statistical Process Control Software)

total case volume. The Pareto diagram reveals that a comprehensive prematurity risk assessment and prevention program complemented by patient-specific antepartum management has the potential to improve a significant number of Level II neonate's diagnosis. A recommendation for future research would be to use the logistic multiple regression model developed in the El Bastawissi (1993) study in a longitudinal design to determine its predictive efficiency with military beneficiaries in Colorado Springs and the effects on delivery outcome.

The second recommendation concerns case management of neonates who must be referred to Memorial Hospital's NICU. EACH has acquired a substantial amount of NICU equipment from FAMC, which has greatly enhanced the capability of the nursery to handle minimal acuity Level II neonates during the past year and the step down neonates discharged from the Memorial NICU. The second recommendation from the current research is that active case management of those neonates admitted to the Memorial NICU continue to step down those infants to the greatest extent possible based on nursery staffing and capability. Coupled with a prematurity risk assessment and prevention program, these are the best actions to prevent and recapture NICU volume on the Memorial hospital unit, short of creating a Level II NICU at EACH.

The third recommendation is relevant to the TRICARE operating environment in general and the NICU financial analysis conducted by this study in particular. The availability of an

integrated medical information system which reliably combines patient clinical treatment, ancillary services, logistic, and personnel database information in relational architecture is urgently required in every military hospital's information management infrastructure. The lack of capacity to swiftly query, integrate, and create needed information from the existing quandary of database systems is an extreme liability in the TRICARE era, especially with regard to cost accounting and cost finding systems. The inability to obtain instantaneous patient data and quickly and accurately determine what treatment product lines and services cost within a military treatment facility make contract evaluation and make/ buy decisions extremely difficult. The TRICARE era will frequently demand critical timing and accuracy of such evaluations in order for military treatment facilities to evaluate the efficency and effectiveness of their operations.

In summary, the Level II NICU project is not recommended for implementation due to questionable financial feasibility and strategic situational constraints. The best alternative is to continue to obtain NICU services from Memorial Hospital, while improving prematurity prevention and case management to minimize volume and length of stay to the greatest extent possible.

APPENDIX A

SPREADSHEET CELL FORMULAE

```
E2: [W14] "TABLE
F2: [W14] '11
E4: [W14] 'LEVEL II NICU PROJECT EVALUATION
E5: [W14] 'Five Year Incremental Analysis
A6: [W6] \=
B6: [W25] \=
C6: [W9] \=
D6: [W18] \=
E6: [W14] \=
F6: [W14] \=
G6: [W14] \=
H6: [W14] \=
I6: [W14] \=
B8: [W25] 'INPUT VARIABLES:
D8: [W18] '
G8: [W14] 'OUTPUT VARIABLES:
B9: [W25] 'Discount Rate
C9: (P3) [W9] @SIMTABLE(0.04,0.045,0.05,0.055,4)
D9: [W18] "Trng/ CME
E9: (C0) [W14] 20000
G9: [W14] 'Nominal Salary
H9: (C0) [W14] (A16*C16+A17*C17+A18*C18+A19*C19+A20*C20+A21*C21+A22*C22+A25*C:
B10: [W25] 'Inflation Rate
C10: (P3) [W9] 0.025
D10: [W18] "NURSY OBD
E10: [W14] 2610
B11: [W25] 'Births per 1000 females
C11: (F3) [W9] 82
D11: [W18] "ANCIL SVCS
E11: (C0) [W14] 289615
G11: [W14] '5 YEAR VOLUME PROJECTION:
B12: [W25] 'CATCHMENT Growth Rate
C12: (P3) [W9] 0.02
D12: [W18] "ADMIN OVHD
E12: (C0) [W14] 145945
B13: [W25] 'FY'94 NICU Recapture
C13: (C0) [W9] 509761
G13: [W14] "FY '94
H13: [W14] "BIRTHS
I13: [W14] "INCREM OBD
G14: [W14] "BASELINE
H14: [W14] 2441
I14: [W14] @SUM($D$50..$D$58)
A15: [W6] ^QTY
B15: [W25] 'CLINICAL STAFF
C15: [W9] "SALARY
D15: [W18] "AVG COST
E15: [W14] "FY '94
F15: [W14] "AVG COST
G15: [W14] "-----
H15: [W14] "-----
I15: [W14] "-----
A16: [W6] 0
B16: [W25] 'Pediatrician
```

```
C16: (C0) [W9] 148400
D16: [W18] "PER DISCHG
E16: [W14] "(@TNORMAL)
F16: [W14] ^INDEX
G16: [W14] 1996
H16: (F0) [W14] ($E$35/1000)*$C$11
I16: (F0) [W14] @SUM($E$50..$E$58)
A17: [W6] 0
B17: [W25] 'Neonatal Nurse Pract
C17: (C0) [W9] 77316
D17: [W18] "DRG 613
E17: (C0) [W14] (@TNORMAL(16871,2980,11500,22250))*(1+F17)^2
F17: (P2) [W14] 0.05
G17: [W14] 1997
H17: (F0) [W14] ($F$35/1000)*$C$11
I17: (F0) [W14] @SUM($F$50..$F$58)
A18: [W6] 1
B18: [W25] 'Clinical Nurse Sp (GS-11)
C18: (C0) [W9] 51961
D18: [W18] "DRG 614
E18: (C0) [W14] (@TNORMAL(17122,3550,10250,24000))*(1+F17)^2
G18: [W14] 1998
H18: (F0) [W14] ($G$35/1000)*$C$11
I18: (F0) [W14] @SUM($G$50..$G$58)
A19: [W6] 2.5
B19: [W25] 'Registered Nurse  (GS-10)
C19: (C0) [W9] 48235
D19: [W18] "DRG 619
E19: (C0) [W14] (@TNORMAL(5928,1593,2750,9100))*(1+F17)^2
G19: [W14] 1999
H19: (F0) [W14] ($H$35/1000)*$C$11
I19: (F0) [W14] @SUM($H$50..$H$58)
A20: [W6] 2
B20: [W25] 'Lic Pract. Nurse  (GS-7)
C20: (C0) [W9] 29061
D20: [W18] "DRG 621
E20: (C0) [W14] (@TNORMAL(4851,1438,1975,7730))*(1+F17)^2
G20: [W14] 2000
H20: (F0) [W14] ($I$35/1000)*$C$11
I20: (F0) [W14] @SUM($I$50..$I$58)
A21: [W6] 3.5
B21: [W25] 'R.N. Upgrade (GS-9 to 10)
C21: (C0) [W9] 6500
D21: [W18] "DRG 627
E21: (C0) [W14] (@TNORMAL(7662,2060,3542,11800))*(1+F17)^2
H21: (F0) [W14] "=====
I21: [W14] "=====
A22: [W6] 7
B22: [W25] 'LPN Upgrade  (GS-5 to 6)
C22: (C0) [W9] 2457
D22: [W18] "DRG 628
E22: (C0) [W14] (@TNORMAL(3242,1192,858,5625))*(1+F17)^2
G22: [W14] "TOTAL
H22: (F0) [W14] @SUM(H16..H20)
```

```
I22: (F0) [W14] @SUM(I16..I20)
D23: [W18] "DRG 630
E23: (C0) [W14] (@TNORMAL(1246,335,575,1925))*(1+F17)^2
A24: [W6] ^QTY
B24: [W25] 'ANCILLARY STAFF
G24: [W14] 'NPV of PROJECT
I24: (C0) [W14] +D77
A25: [W6] 1
B25: [W25] 'Med Soc Worker    (GS-11)
C25: (C0) [W9] 47928
A26: [W6] 1
B26: [W25] 'Clin Case Mgr     (GS-10)
C26: (C0) [W9] 48535
G26: [W14] 'INTERNAL RATE OF RETURN
I26: (P2) [W14] +D79
A27: [W6] 0
B27: [W25] 'Respir Therap     (GS-7)
C27: (C0) [W9] 34180
A28: [W6] 0.5
B28: [W25] 'Pharmacy Tech     (GS-5)
C28: (C0) [W9] 26140
A29: [W6] 0
B29: [W25] 'Cytotechnologist  (GS-6)
C29: (C0) [W9] 29137
A30: [W6] 0
B30: [W25] 'Ward Clerk        (GS-4)
C30: (C0) [W9] 23364
G30: [W14] 'VOLUME PROJECTIONS
A31: [W6] \*
B31: [W25] \*
C31: [W9] \*
D31: [W18] \*
E31: [W14] \*
F31: [W14] \*
G31: [W14] \*
H31: [W14] \*
I31: [W14] \*
D32: [W18] "FY'94 ACTUAL
E32: [W14] "FY '96
F32: [W14] "FY '97
G32: [W14] "FY '98
H32: [W14] "FY '99
I32: [W14] "FY 2000
A33: [W6] \_
B33: [W25] \_
C33: [W9] \_
D33: [W18] \_
E33: [W14] \_
F33: [W14] \_
G33: [W14] \_
H33: [W14] \_
I33: [W14] \_
B34: [W25] 'CATCHMENT Population
D34: [W18] 130304
```

```
E34: (F0) [W14] (D34-8315)*(1+@NORMAL(C12,0.005))
F34: (F0) [W14] +E34*(1+@NORMAL(C12,0.005))
G34: (F0) [W14] +F34*(1+@NORMAL(C12,0.005))
H34: (F0) [W14] +G34*(1+@NORMAL(C12,0.005))
I34: (F0) [W14] +H34*(1+@NORMAL(C12,0.005))
B35: [W25] 'FEMALES AGE 15-44 YRS
D35: [W18] 29750
E35: (F0) [W14] +$D35/$D34*E34
F35: (F0) [W14] +$D35/$D34*F34
G35: (F0) [W14] +$D35/$D34*G34
H35: (F0) [W14] +$D35/$D34*H34
I35: (F0) [W14] +$D35/$D34*I34
B36: [W25] 'TOTAL Births
D36: [W18] 2440
E36: (F0) [W14] ($E$35/1000)*$C$11
F36: (F0) [W14] ($F$35/1000)*$C$11
G36: (F0) [W14] ($G$35/1000)*$C$11
H36: (F0) [W14] ($H$35/1000)*$C$11
I36: (F0) [W14] ($I$35/1000)*$C$11
A37: [W6] \_
B37: [W25] \_
C37: [W9] \_
D37: [W18] \_
E37: [W14] \_
F37: [W14] \_
G37: [W14] \_
H37: [W14] \_
I37: [W14] \_
B38: [W25] ^[5 Year Historical]
C38: [W9] "(@TRIANG)
B39: [W25] 'DRG 391 Incidence Rate:
C39: (F4) [W9] @TRIANG(0.749,0.7596,0.771)
D39: [W18] 1880
E39: (F0) [W14] +C39*$E$36
F39: (F0) [W14] +C39*$F$36
G39: (F0) [W14] +C39*$G$36
H39: (F0) [W14] +C39*$H$36
I39: (F0) [W14] +C39*$I$36
B40: [W25] 'DRG 613 Incidence Rate:
C40: (F4) [W9] @TRIANG(0.001,0.0025,0.004)
D40: [W18] 4
E40: (F0) [W14] +C40*$E$36
F40: (F0) [W14] +C40*$F$36
G40: (F0) [W14] +C40*$G$36
H40: (F0) [W14] +C40*$H$36
I40: (F0) [W14] +C40*$I$36
B41: [W25] 'DRG 614 Incidence Rate:
C41: (F4) [W9] @TRIANG(0.0015,0.002,0.0025)
D41: [W18] 5
E41: (F0) [W14] +C41*$E$36
F41: (F0) [W14] +C41*$F$36
G41: (F0) [W14] +C41*$G$36
H41: (F0) [W14] +C41*$H$36
I41: (F0) [W14] +C41*$I$36
```

```
B42: [W25] 'DRG 619 Incidence Rate:
C42: (F4) [W9] @TRIANG(0.002,0.0035,0.004)
D42: [W18] 6
E42: (F0) [W14] +C42*$E$36
F42: (F0) [W14] +C42*$F$36
G42: (F0) [W14] +C42*$G$36
H42: (F0) [W14] +C42*$H$36
I42: (F0) [W14] +C42*$I$36
B43: [W25] 'DRG 621 Incidence Rate:
C43: (F4) [W9] @TRIANG(0.015,0.019,0.023)
D43: [W18] 40
E43: (F0) [W14] +C43*$E$36
F43: (F0) [W14] +C43*$F$36
G43: (F0) [W14] +C43*$G$36
H43: (F0) [W14] +C43*$H$36
I43: (F0) [W14] +C43*$I$36
B44: [W25] 'DRG 627 Incidence Rate:
C44: (F4) [W9] @TRIANG(0.0168,0.0262,0.0356)
D44: [W18] 53
E44: (F0) [W14] +C44*$E$36
F44: (F0) [W14] +C44*$F$36
G44: (F0) [W14] +C44*$G$36
H44: (F0) [W14] +C44*$H$36
I44: (F0) [W14] +C44*$I$36
B45: [W25] 'DRG 628 Incidence Rate:
C45: (F4) [W9] @TRIANG(0.0165,0.0234,0.0302)
D45: [W18] 52
E45: (F0) [W14] +C45*$E$36
F45: (F0) [W14] +C45*$F$36
G45: (F0) [W14] +C45*$G$36
H45: (F0) [W14] +C45*$H$36
I45: (F0) [W14] +C45*$I$36
B46: [W25] 'DRG 630 Incidence Rate:
C46: (F4) [W9] @TRIANG(0.12,0.125,0.13)
D46: [W18] 296
E46: (F0) [W14] +C46*$E$36
F46: (F0) [W14] +C46*$F$36
G46: (F0) [W14] +C46*$G$36
H46: (F0) [W14] +C46*$H$36
I46: (F0) [W14] +C46*$I$36
B47: [W25] 'ROUTINE & LEVEL II TOTALS
C47: (F4) [W9] @SUM(C39..C46)
D47: [W18] @SUM(D39..D46)
E47: (F0) [W14] @SUM(E39..E46)
F47: (F0) [W14] @SUM(F39..F46)
G47: (F0) [W14] @SUM(G39..G46)
H47: (F0) [W14] @SUM(H39..H46)
I47: (F0) [W14] @SUM(I39..I46)
A48: [W6] \-
B48: [W25] \-
C48: [W9] \-
D48: [W18] \-
E48: [W14] \-
F48: [W14] \-
```

```
G48: [W14] \-
H48: [W14] \-
I48: [W14] \-
B49: [W25] 'MTF OCC BED DAY BY DRG
C49: [W9] "ALOS
D49: [W18] "FY '94 ACTUAL
F49: [W14] 'INCREMENTAL RECAPTURE: OCCUPIED BED DAYS to BASELINE
A50: [W6] \-
B50: [W25] \-
C50: [W9] \-
D50: [W18] \-
E50: [W14] \-
F50: [W14] \-
G50: [W14] \-
H50: [W14] \-
I50: [W14] \-
B51: [W25] ^BASELINE FY '94
C51: [W9] "(@NORMAL)
D51: [W18] "NAS OBD
B52: [W25] 'DRG 613    ( 0 OBD)
C52: (F2) [W9] @NORMAL(14.7,4.3)
D52: [W18] 93
E52: (F0) [W14] (E40*$C52)-0
F52: (F0) [W14] (F40*$C52)-0
G52: (F0) [W14] (G40*$C52)-0
H52: (F0) [W14] (H40*$C52)-0
I52: (F0) [W14] (I40*$C52)-0
B53: [W25] 'DRG 614    (25 OBD)
C53: (F2) [W9] @NORMAL(8.6,2.7)
D53: [W18] 19
E53: (F0) [W14] (E41*$C53)-25
F53: (F0) [W14] (F41*$C53)-25
G53: (F0) [W14] (G41*$C53)-25
H53: (F0) [W14] (H41*$C53)-25
I53: (F0) [W14] (I41*$C53)-25
B54: [W25] 'DRG 619    (27 OBD)
C54: (F2) [W9] @NORMAL(6.8,2.3)
D54: [W18] 32
E54: (F0) [W14] (E42*$C54)-27
F54: (F0) [W14] (F42*$C54)-27
G54: (F0) [W14] (G42*$C54)-27
H54: (F0) [W14] (H42*$C54)-27
I54: (F0) [W14] (I42*$C54)-27
B55: [W25] 'DRG 621   (107 OBD)
C55: (F2) [W9] @NORMAL(3,0.75)
D55: [W18] 34
E55: (F0) [W14] (E43*$C55)-107
F55: (F0) [W14] (F43*$C55)-107
G55: (F0) [W14] (G43*$C55)-107
H55: (F0) [W14] (H43*$C55)-107
I55: (F0) [W14] (I43*$C55)-107
B56: [W25] 'DRG 627   (126 OBD)
C56: (F2) [W9] @NORMAL(3.4,1.5)
D56: [W18] 106
```

```
E56: (F0) [W14] (E44*$C56)-126
F56: (F0) [W14] (F44*$C56)-126
G56: (F0) [W14] (G44*$C56)-126
H56: (F0) [W14] (H44*$C56)-126
I56: (F0) [W14] (I44*$C56)-126
B57: [W25] 'DRG 628  (138 OBD)
C57: (F2) [W9] @NORMAL(3.3,0.9)
D57: [W18] 38
E57: (F0) [W14] (E45*$C57)-138
F57: (F0) [W14] (F45*$C57)-138
G57: (F0) [W14] (G45*$C57)-138
H57: (F0) [W14] (H45*$C57)-138
I57: (F0) [W14] (I45*$C57)-138
B58: [W25] 'DRG 630  (564 OBD)
C58: (F2) [W9] @NORMAL(2.1,0.68)
D58: [W18] 61
E58: (F0) [W14] (E46*$C58)-564
F58: (F0) [W14] (F46*$C58)-564
G58: (F0) [W14] (G46*$C58)-564
H58: (F0) [W14] (H46*$C58)-564
I58: (F0) [W14] (I46*$C58)-564
B59: [W25] \=
C59: [W9] \=
D59: [W18] "====
E59: [W14] "====
F59: [W14] "====
G59: [W14] "====
H59: [W14] "====
I59: [W14] "====
B60: [W25] 'Incremental OBD
D60: [W18] @SUM($D$50..$D$58)
E60: (F0) [W14] @SUM($E$50..$E$58)
F60: (F0) [W14] @SUM($F$50..$F$58)
G60: (F0) [W14] @SUM($G$50..$G$58)
H60: (F0) [W14] @SUM($H$50..$H$58)
I60: (F0) [W14] @SUM($I$50..$I$58)
A61: [W6] \*
B61: [W25] \*
C61: [W9] \*
D61: [W18] \*
E61: [W14] \*
F61: [W14] \*
G61: [W14] \*
H61: [W14] \*
I61: [W14] \*
B62: [W25] 'CASH FLOW ANALYSIS
D62: [W18] "YEAR:   FY '95
E62: [W14] "'96
F62: [W14] "'97
G62: [W14] "'98
H62: [W14] "'99
I62: [W14] "2000
D63: [W18] 0
E63: [W14] 1
```

```
F63: [W14] 2
G63: [W14] 3
H63: [W14] 4
I63: [W14] 5
B64: [W25] \=
D64: [W18] "=======
E64: [W14] "=======
F64: [W14] "=======
G64: [W14] "=======
H64: [W14] "=======
I64: [W14] "=======
B65: [W25] ' 1. Biomed Equipment
D65: (C0) [W18] -193807
B66: [W25] ' 2. Nursery Renovation
D66: (C0) [W18] -200000
B67: [W25] ' 3. CHAMPUS Recapture
E67: (C0) [W14] ((E40-0)*$E$17+(E41-3)*$E$18+(E42-4)*$E$19+(E43-35)*$E$20+(E4
F67: (C0) [W14] ((F40-0)*$E$17+(F41-3)*$E$18+(F42-4)*$E$19+(F43-35)*$E$20+(F4
G67: (C0) [W14] ((G40-0)*$E$17+(G41-3)*$E$18+(G42-4)*$E$19+(G43-35)*$E$20+(G4
H67: (C0) [W14] ((H40-0)*$E$17+(H41-3)*$E$18+(H42-4)*$E$19+(H43-35)*$E$20+(H4
I67: (C0) [W14] ((I40-0)*$E$17+(I41-3)*$E$18+(I42-4)*$E$19+(I43-35)*$E$20+(I4
B68: [W25] ' 4. Suppl Care Recapture
E68: (C0) [W14] 45473*(1+C10)^E63
F68: (C0) [W14] +E68*(1+C10)^F63
G68: (C0) [W14] +F68*(1+C10)^G63
H68: (C0) [W14] +G68*(1+C10)^H63
I68: (C0) [W14] +H68*(1+C10)^I63
B69: [W25] ' 5. Net Cost Avoidance
E69: (C0) [W14] @SUM(E67..E68)
F69: (C0) [W14] @SUM(F67..F68)
G69: (C0) [W14] @SUM(G67..G68)
H69: (C0) [W14] @SUM(H67..H68)
I69: (C0) [W14] @SUM(I67..I68)
B70: [W25] ' 6. Less Salary
E70: (C0) [W14] +$H$9*(1+$C$10)^E63
F70: (C0) [W14] +E70*(1+$C$10)^F63
G70: (C0) [W14] +F70*(1+$C$10)^G63
H70: (C0) [W14] +G70*(1+$C$10)^H63
I70: (C0) [W14] +H70*(1+$C$10)^I63
B71: [W25] ' 7. Less Training/CME
E71: (C0) [W14] +$E$9
F71: (C0) [W14] +$E$71*(1+$C$10)^E63
G71: (C0) [W14] +$E$71*(1+$C$10)^F63
H71: (C0) [W14] +$E$71*(1+$C$10)^G63
I71: (C0) [W14] +$E$71*(1+$C$10)^H63
B72: [W25] ' 8. Less Ancil Svcs
E72: (C0) [W14] (($E$11/$E$10)*E60)*(1+$C$10)^E63
F72: (C0) [W14] (($E$11/$E$10)*F60)*(1+$C$10)^F63
G72: (C0) [W14] (($E$11/$E$10)*G60)*(1+$C$10)^G63
H72: (C0) [W14] (($E$11/$E$10)*H60)*(1+$C$10)^H63
I72: (C0) [W14] (($E$11/$E$10)*I60)*(1+$C$10)^I63
B73: [W25] ' 9. Less Admin. Overhead
E73: (C0) [W14] (($E$12/$E$10)*E60)*(1+$C$10)^E63
F73: (C0) [W14] (($E$12/$E$10)*F60)*(1+$C$10)^F63
```

```
G73: (C0) [W14] (($E$12/$E$10)*G60)*(1+$C$10)^G63
H73: (C0) [W14] (($E$12/$E$10)*H60)*(1+$C$10)^H63
I73: (C0) [W14] (($E$12/$E$10)*I60)*(1+$C$10)^I63
B74: [W25] \=
D74: (C0) [W18] "==========
E74: (C0) [W14] "==========
F74: (C0) [W14] "==========
G74: (C0) [W14] "==========
H74: (C0) [W14] "==========
I74: (C0) [W14] "==========
B75: [W25] 'NET CASH FLOW
D75: (C0) [W18] @SUM(D65..D73)
E75: (C0) [W14] +E69-@SUM(E70..E73)
F75: (C0) [W14] +F69-@SUM(F70..F73)
G75: (C0) [W14] +G69-@SUM(G70..G73)
H75: (C0) [W14] +H69-@SUM(H70..H73)
I75: (C0) [W14] +I69-@SUM(I70..I73)
B77: [W25] 'NET PRESENT VALUE
D77: (C0) [W18] @NPV(C9,D75..I75)
B79: [W25] 'INTERNAL RATE OF RETURN
D79: (P2) [W18] @IRR(0.06,D75..I75)
```

APPENDIX B

SURVEY FORM

NEONATAL INTENSIVE CARE (NICU) SERVICES

This survey asks you to make a personal assessment of Neonatal Intensive Care services in the Colorado Springs community, relative to 16 specific attributes. **Please complete Part I, answering all questions, <u>before</u> proceeding to Part II.** Completed survey forms should be returned to MAJ Ellenberger.

Part I

In your opinion, **how important** are each of the following attributes in the provision of neonatal intensive care services in Colorado Springs? Please rate <u>each</u> attribute on a scale of 1 to 9 (Unimportant - Important).

	Totally Unimportant				Neutral				Highly Important
1. Providing for continuity of care through an integrated continuum of neonatal care services.	1	2	3	4	5	6	7	8	9
2. Increased risk exposure to institutional medical liability, due to higher patient acuity and treatment complexity.	1	2	3	4	5	6	7	8	9
3. Availability and cost of neonatal transport services.	1	2	3	4	5	6	7	8	9
4. Availability and economic market for pediatric/neonatal physician and nursing providers.	1	2	3	4	5	6	7	8	9
5. Appropriate utilization of care level, care location, and length of stay consistent with the neonate's condition.	1	2	3	4	5	6	7	8	9
6. Accessibility of NICU services to DOD beneficiaries.	1	2	3	4	5	6	7	8	9
7. Availability/use of current technology in neonatal equipment (e.g. ventilators, incubators, monitors) and nursery facilities.	1	2	3	4	5	6	7	8	9

* ***Continued on reverse...*** *

	Totally Unimportant				Neutral				Highly Important
8. Out-of-pocket costs for young enlisted soldiers related to NICU and long-term home care during the first postpartum year.	1	2	3	4	5	6	7	8	9
9. Availability of amenities for neonate, mother and family (attention to convenience, privacy, comfort).	1	2	3	4	5	6	7	8	9
10. Attention to social and emotional needs of the neonate, mother and other family members.	1	2	3	4	5	6	7	8	9
11. Positive clinical outcome of neonatal intensive care, short- and long-term.	1	2	3	4	5	6	7	8	9
12. Impact of inflation in the Colorado Springs healthcare market for NICU services over the next 5 years.	1	2	3	4	5	6	7	8	9
13. Impact of the cost of civilian NICU services on CHAMPUS and military hospital mission funds.	1	2	3	4	5	6	7	8	9
14. Impact of current NICU utilization patterns (i.e. 100% civilian facility) on TRICARE initiatives, contractor bid offers, and subsequent bid price adjustment.	1	2	3	4	5	6	7	8	9
15. Publicity and patient education programs related to NICU services.	1	2	3	4	5	6	7	8	9
16. Availability and timeliness of prematurity prevention measures, such as prenatal care and preterm risk assessment.	1	2	3	4	5	6	7	8	9

Thank you for your assistance.
Please proceed to Part II, and return both forms to MAJ Ellenberger.

NEONATAL INTENSIVE CARE (NICU) SERVICES

Part II

Part II of this survey asks you to make a relative determination of **how well** the Part I attributes **are or would be met** by two hospital systems in the Colorado Springs area, based on the following hypothetical scenario.

Please read the scenario carefully. Then, **apportion a total of 100 points** between the Memorial NICU and EACH NICU systems, according to how well each system fulfills each attribute. If you feel that both systems would be relatively equivalent on an attribute, you would apportion 50 points to each. If you feel that one attribute would be met only by the EACH NICU system, you would apportion 100 points to EACH, none to Memorial. Completed survey forms should be returned to MAJ Ellenberger.

Scenario

EACH opens a Level II Neonatal Intensive Care Unit on 1 Oct 95, with a capacity of 12 ICU bassinets. Admission is limited to neonates with birthweights >1499 gm and/or > 31 weeks gestation, who do NOT require surgical procedures. Short-term ventilatory support is available, as are all ancillary services (e.g. lab, x-ray, pharmacy) to meet Level II certification requirements. Neonates whose care requirements exceed those criteria are referred to the civilian community via a Nonavailability Statement (NAS). In addition, NAS's are provided for routine vaginal deliveries during peak birth months, when the number of births exceed EACH staffing and facility constraints.

Memorial Hospital continues to provide Level I, II and III NICU services, with no substantial change.

The TRICARE baseline period also begins 1 Oct 95, on which prospective contractors' bidding will be based.

	MEMORIAL	+	EACH	= TOTAL
1. Facilitates continuity of neonatal care through an integrated continuum of services.	______	+	______	= 100 pts
2. Minimizes risk exposure, alleviates medical liability claims.	______	+	______	= 100 pts
3. Minimizes cost of contract neonatal transport services.	______	+	______	= 100 pts
4. Adequate number of best qualified and competent physician/nursing staff.	______	+	______	= 100 pts
5. Ensures effective utilization management of appropriate care level resources.	______	+	______	= 100 pts

* ***Continued on reverse...*** *

	MEMORIAL	+	EACH	= TOTAL
6. Easy access to NICU services for all DOD beneficiaries.	______	+	______	= 100 pts
7. Level II equipment and facilities are state-of-the-art.	______	+	______	= 100 pts
8. Minimizes soldiers' out-of-pocket costs for NICU and long-term infant home care.	______	+	______	= 100 pts
9. Provides amenity services/products for neonate, mother and family members.	______	+	______	= 100 pts
10. Addresses social/emotional needs of the neonate, mother and other family members.	______	+	______	= 100 pts
11. NICU clinical outcomes, short- and long-term, are positive.	______	+	______	= 100 pts
12. Constitutes/provides a hedge against local inflation in the NICU services market.	______	+	______	= 100 pts
13. Provides for CHAMPUS cost avoidance/limitation.	______	+	______	= 100 pts
14. Adversely impacts TRICARE initiatives & contractor bidding process/costs.	______	+	______	= 100 pts
15. Provides effective publicity and patient education programs related to NICU services.	______	+	______	= 100 pts
16. Prematurity prevention, including prenatal care/risk assessment, is available & timely.	______	+	______	= 100 pts

Thank you for your assistance.
Please return both forms (Part I, Part II) to MAJ Ellenberger.

APPENDIX C

SENSITIVITY ANALYSIS TABULATION

APPENDIX C

SENSITIVITY ANALYSIS TABULATION

INFLATION RATE: 2.50%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
0.5%	81	4.00%	($321,305)	0.231	-98.4%	0.242
0.5%	81	4.50%	($321,711)	0.235	-100.5%	0.242
0.5%	81	5.00%	($319,027)	0.243	-99.8%	0.252
0.5%	81	5.50%	($315,202)	0.232	-98.5%	0.240
0.5%	82	4.00%	($245,324)	0.288	-87.2%	0.292
0.5%	82	4.50%	($245,497)	0.294	-85.9%	0.306
0.5%	82	5.00%	($246,667)	0.285	-89.1%	0.281
0.5%	82	5.50%	($248,296)	0.275	-88.9%	0.286
0.5%	83	4.00%	($167,203)	0.363	-75.1%	0.356
0.5%	83	4.50%	($167,229)	0.342	-76.7%	0.338
0.5%	83	5.00%	($171,009)	0.346	-74.3%	0.350
0.5%	83	5.50%	($173,865)	0.340	-74.0%	0.346
0.5%	84	4.00%	($92,799)	0.409	-61.0%	0.401
0.5%	84	4.50%	($91,261)	0.397	-66.2%	0.366
0.5%	84	5.00%	($96,087)	0.409	-62.1%	0.412
0.5%	84	5.50%	($101,404)	0.396	-63.5%	0.395
1.0%	81	4.00%	($230,116)	0.300	-79.9%	0.296
1.0%	81	4.50%	($227,995)	0.312	-78.5%	0.316
1.0%	81	5.00%	($228,532)	0.311	-81.1%	0.313
1.0%	81	5.50%	($234,992)	0.290	-79.4%	0.306
1.0%	82	4.00%	($151,932)	0.376	-66.4%	0.371
1.0%	82	4.50%	($152,263)	0.360	-69.4%	0.357
1.0%	82	5.00%	($154,228)	0.351	-66.8%	0.354
1.0%	82	5.50%	($156,994)	0.354	-67.8%	0.363
1.0%	83	4.00%	($78,702)	0.421	-56.5%	0.418
1.0%	83	4.50%	($80,772)	0.415	-57.5%	0.409
1.0%	83	5.00%	($79,952)	0.423	-55.6%	0.424
1.0%	83	5.50%	($81,802)	0.416	-55.9%	0.418
1.0%	84	4.00%	$1,953	0.473	-44.5%	0.465
1.0%	84	4.50%	($5,048)	0.457	-45.0%	0.439
1.0%	84	5.00%	($9,899)	0.468	-44.8%	0.461
1.0%	84	5.50%	($10,375)	0.462	-45.2%	0.459

(continued)

APPENDIX C

SENSITIVITY ANALYSIS TABULATION (continued)

INFLATION RATE: 2.50%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
1.5%	81	4.00%	($133,893)	0.383	-57.8%	0.381
1.5%	81	4.50%	($140,817)	0.363	-60.5%	0.371
1.5%	81	5.00%	($138,092)	0.372	-59.0%	0.375
1.5%	81	5.50%	($144,912)	0.363	-58.0%	0.377
1.5%	82	4.00%	($55,643)	0.444	-49.2%	0.441
1.5%	82	4.50%	($59,491)	0.409	-50.4%	0.409
1.5%	82	5.00%	($67,255)	0.420	-49.4%	0.422
1.5%	82	5.50%	($66,862)	0.418	-47.3%	0.417
1.5%	83	4.00%	$21,302	0.489	-38.2%	0.473
1.5%	83	4.50%	$14,520	0.480	-36.9%	0.470
1.5%	83	5.00%	$9,126	0.483	-37.3%	0.484
1.5%	83	5.50%	$8,290	0.494	-39.6%	0.492
1.5%	84	4.00%	$107,692	0.545	-28.0%	0.525
1.5%	84	4.50%	$96,629	0.539	-28.9%	0.518
1.5%	84	5.00%	$86,750	0.533	-27.4%	0.533
1.5%	84	5.50%	$80,740	0.530	-26.9%	0.526
2.0%	81	4.00%	($37,123)	0.439	-38.3%	0.441
2.0%	81	4.50%	($40,990)	0.446	-41.6%	0.447
2.0%	81	5.00%	($56,777)	0.433	-42.6%	0.441
2.0%	81	5.50%	($53,612)	0.437	-43.4%	0.442
2.0%	82	4.00%	$40,267	0.505	-31.2%	0.500
2.0%	82	4.50%	$33,655	0.487	-31.7%	0.485
2.0%	82	5.00%	$24,948	0.499	-30.6%	0.509
2.0%	82	5.50%	$24,988	0.485	-32.5%	0.478
2.0%	83	4.00%	$119,902	0.564	-22.7%	0.548
2.0%	83	4.50%	$110,546	0.568	-21.0%	0.557
2.0%	83	5.00%	$103,847	0.545	-22.9%	0.529
2.0%	83	5.50%	$93,703	0.544	-21.8%	0.538
2.0%	84	4.00%	$198,786	0.615	-15.4%	0.585
2.0%	84	4.50%	$192,045	0.623	-14.3%	0.597
2.0%	84	5.00%	$181,513	0.610	-12.9%	0.594
2.0%	84	5.50%	$174,274	0.619	-13.0%	0.604

APPENDIX C

SENSITIVITY ANALYSIS TABULATION

INFLATION RATE: 3.00%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
0.5%	81	4.00%	($358,626)	0.236	-106.9%	0.248
0.5%	81	4.50%	($359,008)	0.215	-108.6%	0.224
0.5%	81	5.00%	($349,165)	0.221	-104.4%	0.238
0.5%	81	5.50%	($349,998)	0.226	-106.9%	0.240
0.5%	82	4.00%	($280,043)	0.279	-95.7%	0.283
0.5%	82	4.50%	($284,430)	0.271	-96.8%	0.270
0.5%	82	5.00%	($277,906)	0.280	-96.7%	0.283
0.5%	82	5.50%	($276,917)	0.267	-95.5%	0.275
0.5%	83	4.00%	($202,276)	0.335	-83.3%	0.338
0.5%	83	4.50%	($202,594)	0.317	-82.7%	0.335
0.5%	83	5.00%	($204,284)	0.333	-83.6%	0.336
0.5%	83	5.50%	($206,070)	0.313	-83.3%	0.329
0.5%	84	4.00%	($128,677)	0.377	-70.4%	0.379
0.5%	84	4.50%	($131,113)	0.381	-72.6%	0.376
0.5%	84	5.00%	($126,535)	0.378	-70.9%	0.381
0.5%	84	5.50%	($131,962)	0.377	-69.4%	0.381
1.0%	81	4.00%	($263,891)	0.297	-89.8%	0.422
1.0%	81	4.50%	($263,821)	0.288	-88.1%	0.450
1.0%	81	5.00%	($261,822)	0.283	-92.1%	0.417
1.0%	81	5.50%	($262,939)	0.276	-91.1%	0.428
1.0%	82	4.00%	($184,155)	0.354	-74.9%	0.473
1.0%	82	4.50%	($184,158)	0.333	-78.9%	0.456
1.0%	82	5.00%	($186,877)	0.335	-77.5%	0.473
1.0%	82	5.50%	($186,957)	0.339	-76.7%	0.463
1.0%	83	4.00%	($105,931)	0.396	-66.1%	0.503
1.0%	83	4.50%	($110,470)	0.391	-63.9%	0.534
1.0%	83	5.00%	($108,548)	0.393	-66.7%	0.526
1.0%	83	5.50%	($113,121)	0.386	-66.8%	0.525
1.0%	84	4.00%	($26,919)	0.455	-54.5%	0.565
1.0%	84	4.50%	($29,765)	0.442	-55.4%	0.565
1.0%	84	5.00%	($31,913)	0.455	-52.2%	0.560
1.0%	84	5.50%	($42,244)	0.440	-57.1%	0.575

(continued)

APPENDIX C

SENSITIVITY ANALYSIS TABULATION (continued)

INFLATION RATE: 3.00%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	NPV	p of NPV >$0	IRR	p of IRR >0.0%
1.5%	81	4.00%	($168,297)	0.355	-69.9%	0.358
1.5%	81	4.50%	($169,141)	0.355	-69.9%	0.358
1.5%	81	5.00%	($170,979)	0.354	-68.6%	0.359
1.5%	81	5.50%	($173,172)	0.345	-72.1%	0.352
1.5%	82	4.00%	($93,344)	0.405	-56.6%	0.408
1.5%	82	4.50%	($95,255)	0.405	-56.8%	0.409
1.5%	82	5.00%	($94,636)	0.402	-59.2%	0.405
1.5%	82	5.50%	($97,560)	0.402	-58.4%	0.403
1.5%	83	4.00%	($6,757)	0.466	-48.7%	0.438
1.5%	83	4.50%	($13,846)	0.473	-47.5%	0.459
1.5%	83	5.00%	($21,705)	0.454	-46.0%	0.457
1.5%	83	5.50%	($18,533)	0.450	-48.7%	0.440
1.5%	84	4.00%	$72,442	0.524	-36.5%	0.504
1.5%	84	4.50%	$65,313	0.505	-38.6%	0.490
1.5%	84	5.00%	$62,463	0.526	-39.0%	0.498
1.5%	84	5.50%	$54,269	0.519	-38.6%	0.506
2.0%	81	4.00%	($70,077)	0.425	-49.5%	0.432
2.0%	81	4.50%	($74,967)	0.406	-51.8%	0.403
2.0%	81	5.00%	($76,305)	0.425	-50.8%	0.430
2.0%	81	5.50%	($86,564)	0.405	-51.0%	0.416
2.0%	82	4.00%	$7,808	0.485	-42.6%	0.470
2.0%	82	4.50%	$5,348	0.480	-38.8%	0.478
2.0%	82	5.00%	($1,982)	0.480	-39.0%	0.480
2.0%	82	5.50%	($3,895)	0.475	-38.4%	0.468
2.0%	83	4.00%	$98,030	0.541	-28.4%	0.522
2.0%	83	4.50%	$81,960	0.517	-31.9%	0.496
2.0%	83	5.00%	$74,357	0.530	-31.1%	0.513
2.0%	83	5.50%	$70,760	0.523	-30.7%	0.511
2.0%	84	4.00%	$172,476	0.585	-23.0%	0.554
2.0%	84	4.50%	$166,049	0.590	-21.2%	0.568
2.0%	84	5.00%	$156,044	0.588	-22.7%	0.562
2.0%	84	5.50%	$147,265	0.599	-20.6%	0.581

APPENDIX C

SENSITIVITY ANALYSIS TABULATION

INFLATION RATE: 3.50%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
0.5%	81	4.00%	($398,565)	0.221	-117.2%	0.222
0.5%	81	4.50%	($398,026)	0.205	-115.9%	0.227
0.5%	81	5.00%	($390,113)	0.210	-117.4%	0.213
0.5%	81	5.50%	($384,717)	0.214	-116.2%	0.218
0.5%	82	4.00%	($320,718)	0.244	-109.3%	0.237
0.5%	82	4.50%	($319,388)	0.253	-109.0%	0.242
0.5%	82	5.00%	($315,377)	0.247	-111.1%	0.245
0.5%	82	5.50%	($311,747)	0.253	-106.3%	0.250
0.5%	83	4.00%	($238,286)	0.322	-94.6%	0.315
0.5%	83	4.50%	($239,486)	0.300	-97.7%	0.293
0.5%	83	5.00%	($239,495)	0.308	-95.0%	0.300
0.5%	83	5.50%	($237,313)	0.301	-96.5%	0.299
0.5%	84	4.00%	($161,087)	0.367	-85.9%	0.351
0.5%	84	4.50%	($161,137)	0.345	-82.7%	0.342
0.5%	84	5.00%	($166,490)	0.345	-81.4%	0.348
0.5%	84	5.50%	($163,808)	0.345	-82.5%	0.345
1.0%	81	4.00%	($301,409)	0.275	-99.1%	0.273
1.0%	81	4.50%	($298,998)	0.266	-99.2%	0.275
1.0%	81	5.00%	($303,071)	0.267	-98.6%	0.290
1.0%	81	5.50%	($295,329)	0.258	-97.9%	0.271
1.0%	82	4.00%	($219,090)	0.314	-85.6%	0.321
1.0%	82	4.50%	($218,899)	0.317	-87.4%	0.317
1.0%	82	5.00%	($220,961)	0.322	-86.1%	0.324
1.0%	82	5.50%	($221,680)	0.313	-87.9%	0.329
1.0%	83	4.00%	($139,691)	0.373	-74.5%	0.366
1.0%	83	4.50%	($149,886)	0.360	-72.8%	0.378
1.0%	83	5.00%	($144,793)	0.367	-75.5%	0.381
1.0%	83	5.50%	($145,918)	0.358	-75.0%	0.361
1.0%	84	4.00%	($62,886)	0.425	-63.8%	0.422
1.0%	84	4.50%	($59,187)	0.438	-60.4%	0.433
1.0%	84	5.00%	($66,268)	0.436	-60.8%	0.434
1.0%	84	5.50%	($72,860)	0.419	-64.0%	0.411

(continued)

APPENDIX C

SENSITIVITY ANALYSIS TABULATION (continued)

INFLATION RATE: 3.50%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
1.5%	81	4.00%	($203,221)	0.325	-79.9%	0.331
1.5%	81	4.50%	($205,990)	0.330	-79.4%	0.333
1.5%	81	5.00%	($206,215)	0.325	-78.4%	0.339
1.5%	81	5.50%	($205,809)	0.310	-78.9%	0.327
1.5%	82	4.00%	($125,043)	0.383	-68.4%	0.380
1.5%	82	4.50%	($127,187)	0.379	-66.8%	0.382
1.5%	82	5.00%	($127,395)	0.380	-65.4%	0.393
1.5%	82	5.50%	($128,716)	0.379	-65.7%	0.393
1.5%	83	4.00%	($42,086)	0.452	-54.7%	0.451
1.5%	83	4.50%	($47,777)	0.444	-54.7%	0.447
1.5%	83	5.00%	($45,654)	0.424	-55.6%	0.425
1.5%	83	5.50%	($53,246)	0.428	-56.4%	0.436
1.5%	84	4.00%	$39,681	0.503	-42.3%	0.496
1.5%	84	4.50%	$33,316	0.493	-45.0%	0.487
1.5%	84	5.00%	$27,899	0.488	-48.0%	0.475
1.5%	84	5.50%	$25,316	0.484	-47.5%	0.471
2.0%	81	4.00%	($104,033)	0.400	-62.0%	0.390
2.0%	81	4.50%	($112,349)	0.386	-62.1%	0.395
2.0%	81	5.00%	($111,610)	0.395	-61.1%	0.405
2.0%	81	5.50%	($111,934)	0.395	-59.0%	0.416
2.0%	82	4.00%	($24,542)	0.452	-48.5%	0.448
2.0%	82	4.50%	($23,385)	0.452	-51.2%	0.439
2.0%	82	5.00%	($32,274)	0.441	-49.1%	0.434
2.0%	82	5.50%	($35,050)	0.448	-52.6%	0.444
2.0%	83	4.00%	$59,781	0.514	-39.2%	0.489
2.0%	83	4.50%	$58,829	0.518	-37.3%	0.503
2.0%	83	5.00%	$47,714	0.503	-38.3%	0.498
2.0%	83	5.50%	$42,446	0.511	-40.4%	0.492
2.0%	84	4.00%	$141,352	0.578	-28.6%	0.544
2.0%	84	4.50%	$137,189	0.582	-26.5%	0.557
2.0%	84	5.00%	$123,989	0.570	-28.6%	0.561
2.0%	84	5.50%	$120,546	0.556	-30.4%	0.549

APPENDIX C

SENSITIVITY ANALYSIS TABULATION

INFLATION RATE: 4.00%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
0.5%	81	4.00%	($443,539)	0.188	-131.2%	0.185
0.5%	81	4.50%	($435,412)	0.193	-129.6%	0.182
0.5%	81	5.00%	($431,226)	0.187	-130.1%	0.188
0.5%	81	5.50%	($425,014)	0.192	-128.4%	0.195
0.5%	82	4.00%	($358,060)	0.243	-118.1%	0.230
0.5%	82	4.50%	($354,134)	0.235	-121.2%	0.223
0.5%	82	5.00%	($353,556)	0.229	-119.7%	0.228
0.5%	82	5.50%	($352,021)	0.227	-116.9%	0.228
0.5%	83	4.00%	($280,501)	0.280	-108.2%	0.268
0.5%	83	4.50%	($276,487)	0.284	-109.8%	0.264
0.5%	83	5.00%	($279,051)	0.274	-108.3%	0.257
0.5%	83	5.50%	($276,122)	0.275	-108.3%	0.271
0.5%	84	4.00%	($198,090)	0.338	-95.2%	0.310
0.5%	84	4.50%	($198,769)	0.331	-96.4%	0.313
0.5%	84	5.00%	($199,021)	0.335	-95.5%	0.318
0.5%	84	5.50%	($197,848)	0.328	-95.1%	0.310
1.0%	81	4.00%	($337,974)	0.373	-111.2%	0.242
1.0%	81	4.50%	($338,187)	0.370	-107.9%	0.247
1.0%	81	5.00%	($335,744)	0.365	-109.7%	0.259
1.0%	81	5.50%	($335,458)	0.359	-109.9%	0.259
1.0%	82	4.00%	($259,752)	0.427	-98.4%	0.288
1.0%	82	4.50%	($263,641)	0.434	-98.9%	0.286
1.0%	82	5.00%	($260,163)	0.432	-98.0%	0.284
1.0%	82	5.50%	($263,623)	0.429	-99.4%	0.284
1.0%	83	4.00%	($176,527)	0.483	-86.9%	0.334
1.0%	83	4.50%	($180,023)	0.479	-85.5%	0.358
1.0%	83	5.00%	($181,794)	0.491	-87.3%	0.349
1.0%	83	5.50%	($179,931)	0.500	-84.1%	0.350
1.0%	84	4.00%	($98,648)	0.545	-74.0%	0.385
1.0%	84	4.50%	($99,428)	0.540	-71.0%	0.404
1.0%	84	5.00%	($107,634)	0.534	-75.6%	0.380
1.0%	84	5.50%	($105,424)	0.533	-71.6%	0.404

(continued)

APPENDIX C

SENSITIVITY ANALYSIS TABULATION (continued)

INFLATION RATE: 4.00%

SAMPLING: LATIN HYPERCUBIC ITERATIONS: 2000

CATCH GROWTH	BIRTHS PER 1000	DISCOUNT RATE	MEAN NPV	p of NPV >$0	MEAN IRR	p of IRR >0.0%
1.5%	81	4.00%	($243,440)	0.307	-90.2%	0.307
1.5%	81	4.50%	($248,599)	0.298	-91.5%	0.308
1.5%	81	5.00%	($246,961)	0.289	-92.0%	0.297
1.5%	81	5.50%	($241,274)	0.304	-89.0%	0.319
1.5%	82	4.00%	($160,078)	0.364	-77.6%	0.371
1.5%	82	4.50%	($162,382)	0.360	-77.0%	0.364
1.5%	82	5.00%	($164,839)	0.362	-76.9%	0.367
1.5%	82	5.50%	($169,121)	0.350	-78.1%	0.363
1.5%	83	4.00%	($79,526)	0.432	-63.4%	0.428
1.5%	83	4.50%	($78,514)	0.423	-64.5%	0.425
1.5%	83	5.00%	($79,376)	0.419	-62.8%	0.426
1.5%	83	5.50%	($89,078)	0.415	-64.6%	0.422
1.5%	84	4.00%	$6,949	0.488	-51.8%	0.488
1.5%	84	4.50%	($1,383)	0.474	-51.2%	0.477
1.5%	84	5.00%	($5,548)	0.466	-52.7%	0.471
1.5%	84	5.50%	($6,715)	0.462	-54.7%	0.452
2.0%	81	4.00%	($136,123)	0.391	-70.1%	0.387
2.0%	81	4.50%	($143,104)	0.373	-70.9%	0.378
2.0%	81	5.00%	($146,375)	0.369	-70.0%	0.371
2.0%	81	5.50%	($150,717)	0.356	-71.6%	0.370
2.0%	82	4.00%	($60,710)	0.428	-58.2%	0.423
2.0%	82	4.50%	($60,235)	0.424	-55.2%	0.434
2.0%	82	5.00%	($68,955)	0.441	-56.1%	0.450
2.0%	82	5.50%	($71,727)	0.422	-58.7%	0.432
2.0%	83	4.00%	$24,055	0.496	-47.7%	0.480
2.0%	83	4.50%	$23,046	0.486	-44.3%	0.485
2.0%	83	5.00%	$16,075	0.480	-46.3%	0.487
2.0%	83	5.50%	$12,512	0.488	-45.9%	0.489
2.0%	84	4.00%	$106,860	0.545	-35.5%	0.535
2.0%	84	4.50%	$104,601	0.550	-36.6%	0.536
2.0%	84	5.00%	$97,038	0.541	-35.5%	0.538
2.0%	84	5.50%	$90,413	0.543	-33.1%	0.551

REFERENCES

Als, Heidelise, Gretchen Lawhon, Frank H. Duffy, Gloria B. McAnulty, Rita Gibes-Grossman, and Johann Blickman. "Individualized Developmental Care for the Very Low Birth Weight, Pre-term Infant." Journal of the American Medical Association. **272** (Sep. 21, 1994): 853-58.

Army Medical Department Property Accounting System, Department of the Army, Rock Island Arsenal, Illinois.

American Board of Obstetrics and Gynecology. Guidelines for Perinatal Care. Boston: Holt, Reinhart, and Winston, 1993.

Andersen, H.F., M.C. Freda and K. Damus. "Effectiveness of Patient Education to Reduce Preterm Delivery among Ordinary Risk Patients." American Journal of of Perinatology. **6** (1989): 214-17.

@RISK Version 2.01, Palisade Coporation, Newfield, New York.

Badgett, Arthur L., Ph D., Department of the Army Civilian. Chief, Managed Care Division, Evans Army Community Hospital. Interview by author, September 30, 1994; Fort Carson, Colorado.

________. "Newborn Nursery Upgrade Inititative." Memorandum for COL William Mantia, Chief, Coordinated Care at Fitzsimons Army Medical Center. Fort Carson, September 22, 1994.

________. "Neonatal Intensive Care Unit Cost Benefit Analysis." Memorandum for COL William Mantia, Chief, Managed Care Division at Fitzsimons Army Medical Center. Fort Carson, October 27, 1994.

Berman, Howard J., Steven F. Kukla, and Lewis F. Weeks. The Financial Management of Hospitals, 8th ed. Chicago: Health Administration Press, 1993.

Boyle, Michael H., George W. Torrance, John C. Sinclair, and Sargent P. Horwood. "Economic Evaluation of Neonatal Intensive Care of Very-Low-Birthweight Infants." New England Journal of Medicine. **308**: (1983) 1330-37.

British Neonatal Network. "The Clinical Risk Index for Babies (CRIB): Initial Neonatal Risk and Comparing Performance of Neonatal Intensive Care Units." Lancet **342** (July 1993): 193-98.

Cefaly, Patricia L., Lieutenant Colonel, USA. Chief, Patient Support Division, Evans Army Community Hospital. Interview by author, September 28, 1994, Fort Carson, Colorado.

Cleverly, William O. Essentials of Health Care Finance, 3rd ed. Gaithersburg: Aspen Publishers, 1992.

Connolly, M., G. Fox, G. O'Connor, T. Clark, and T. Matthews. "Cost of Neonatal Intensive and Special Care." Irish Medical Journal. **150** (May 15, 1989): 572-75.

Creasy, R. and R. Resnik. Maternal-Fetal Medicine: Principles and Practice, 2nd ed. Philadelphia: W.B. Saunders Company, 1989.

Dai, Joseph J., Lieutenant Colonel, USA. Chief, Pediatric Services, Evans Army Community Hospital. Interview by author, September 26, 1994; Fort Carson, Colorado.

Defense Medical Information System, Department of Defense Medical Systems Support Center, Falls Church, Virginia.

DeMeer, Kees, Roland Bergman, and John S. Kusner. "Socio-Cultural Determinants of Child Mortality in Southern Peru." Social Science Medicine. **36** (Spring 1993): 317-31.

Donabedian, Avedis. The Definition of Quality and Approaches to Its Assessment, Volume I. Ann Arbor: Health Administration Press, 1980.

Downs, Denise M. Department of the Army Civilian. Chief, Systems Analysis Branch, Managed Care Division, Evans Army Community Hospital. Informal interview by author, 25 May 1995, Fort Carson, Colorado.

El-Bastawissi, Amira Youssef. "A Case Control Study to Identify Risk Factors for Preterm Labor in Colorado Springs, Colorado." Ph D. diss. University of Texas Health Science Center at Houston, School of Public Health, 1994.

Ernest, J., R. Michielutte and P. Meis. "Identification of Women at High Risk for Preterm, Low Birthweight Births." Preventive Medicine. **17** (1988): 60-72.

Eskenazi, B., L. Fenster and S. Sidney. "A Multivariate Analysis of Risk Factors for Preeclampsia." Journal of the American Medical Association. **226** (1991): 237-41.

Fenton, Alan C. and David J. Field. "Shortfall of Equipment for Neonatal Intesive Care and the Introduction of Budget Holding Contracts." British Medical Journal. **301** (July 1990): 201-3.

Finstuen, Kenn. "Judging Utility: A Decision Generator and Evaluator (JUDGE)." Quantitative method presented in Research Methods lecture, February 8, 1994. U.S. Army - Baylor University, Fort Sam Houston, Texas.

Fleiss, Joseph L. Statistical Methods for Rates and Proportions, 2nd ed. New York: John Wiley and Sons, 1981.

Gapenski, Louis C. Understanding Health Care Financial Management. Chicago: Health Administration Press, 1994.

Heffner, Linda J., Charles B. Sherman, Frank E. Speizer, and Scott Weiss. "Clinical and Environmental Predictors of Preterm Labor." Obstetrics and Gynecology. **81** (1993): 750-57.

Holbrook, R., R. Laros, and R. Creasy. "Evaluation of a Risk Scoring System for Preterm Labor." American Journal of Perinatology. **6** (1989): 62-68.

Imershein, Allen W., Carolyn Turner, Janice Wells, and Allen Pearman. "Covering the Costs of Care in Neonatal Intensive Care Units." Pediatrics. **89** (January 1992): 56-62.

Joint Commission on Accreditation of Health Care Organizations. 1995 Consolidated Accreditation Manual for Hospitals. Oakbrook, IL: Joint Commission Press, 1994.

Jones, Stephen R., Lieutenant Colonel, USA. Chief Obstetric and Gynecologic Services, Evans Army Community Hospital. Interview by author, September 13, 1994, Fort Carson, Colorado.

Jones, Ronald J., Colonel, USA. Deputy Commander for Clinical Services, Evans Army Community Hospital. Interview by author, September 15, 1994, Fort Carson, Colorado.

Kephart, Tami L., Lieutenant Colonel, USA. Director, Exceptional Family Member Program, Evans Army Community Hospital. Interview by author, April 25, 1995, Fort Carson, Colorado.

Klaus, Marshall H., and Avroy A. Fanaroff. Care of the High Risk Neonate, 4th ed. Philadelphia: W. B. Saunders Company, 1994.

Levin, Richard I., David S. Rubin, Joel P. Stinson, and Everette S. Gardner, Jr. Quantitative Approaches to Management, 8th ed. New York: Mc Graw-Hill, 1992.

Lobas, Nancy H., John A. Armistead, and Marianne Ivey. "Expanding Staff Pharmacists' Responsibilities to Maintain Pharmacy Services in a Neonatal Intensive Care Unit." American Journal of Hospital Pharmacy. **48** (August 1991): 1708-11.

Lorenz, Eugene W. St. Anthony's DRG Working Guidebook 1994. Alexandria, VA: St. Anthony Publishing, 1993.

Lotus 1-2-3 Release 2.2 (U.S. Government ed.), Lotus Development Corporation, Cambridge, Massachusetts.

Mahfouz, A. R., M. M. El-Said, and R. A. Al-Erion. "Altitude and Socio- Biological Determinants of Pregnany-associated Hypertension." International Journal of Obstetrics and Gynecology. **44** (1994): 135-38.

Mantia, William M., Colonel, USA. "TRICARE Region 8 Health Services Plan." Fitzsimmons Army Medical Center, Aurora, Colorado: October 6, 1994.

________. "MTF Capacity / Capability and CHAMPUS Recapture." Department of Defense Health Services Region 8 Lead Agent Staff Issue Review #9502B. Aurora, Colorado: April 1995.

Mayhew, Terry M. "Scaling Placental Oxygen Diffusion to Birthweight: Studies on Placentae from Low and High Altitude Pregnancies." British Journal of Anatomy. **175** (January 1991): 187-94.

McCormick, Marie C., Judy C. Bernbaum, John M. Eisenberg, Sharon L. Kustra, and Emily Finnegan. "Costs Incurred by Parents of Very Low Birth Weight Infants after the Initial Neontal Hospitalization." Pediatrics. **88** (September 1991): 533-41.

Medical Analysis Support System Version 3.0, Department of the Army Medical Command, Fort Sam Houston, Texas.

Medical Expense and Performance Reporting System, Department of Defense, Alexandria, Virginia.

Montgomery, John, Captain, USN. "Bid Price Adjustments and Resource Sharing in Managed Care Support Contracts." Lecture outline and notes, October 1994. Office of the Assistant Secretary of Defense (Health Affairs), Washington D.C.

Moore, Lorna G., Douglas W. Hershey, Dennis Jahnigen, and Watson Bowes, Jr. "The Incidence of Pregnancy-induced Hypertension is Increased among Colorado Residents at High Altitude." American Journal of Obstetrics and Gynecology. **144** (October 1992): 423-29.

Moore, Thomas R. and Jonathan E. Cayle. "The Amniotic Fluid Index in Normal Human Pregnancy." American Journal of Obstetrics and Gynecology. **162** (May 1990): 1168-73.

Navarro, Ramon W., Chief Warrant Officer Two, USA. Chief, Biomedical Maintenance Branch, Evans Army Community Hospital. Interview by author, 24 May 1995, Fort Carson, Colorado.

Neela, J. and L. Raman. "Seasonal Trends in the Occurence of Eclampsia." The National Medical Journal of India. **6** (June 1993): 17-18.

Pearlman, Stephen A., Sharon Stachecki, H. Leon Aussprung, and Nikhil Raval. "Prediciting Length of Hospitalization of Sick Neonates from their Initial Status." Clinical Pediatrics. **31** (July 1992): 22-29.

Phibbs, Ciarin S. and Lynn Mortensen. "Back Transporting Infants from NICU to Community Hospitals for Recovery Care: Effect on Total Hospital Charges." Pediatrics. **90** (July 1992): 22-26.

Pollock, Leslie A., Department of the Army Civilian. Total Quality Management Coordinator, Evans Army Community Hospital.

Retrospective Case Mix Analysis for an Open System Environment, Version 4.3, Department of Defense Medical Systems Support Center, Falls Church, Virginia.

Shankaran, Seetha M., Sanford N. Cohen, Marsha Linver, and Susan Zonia. "Medical Care Costs of High-Risk Infants After Neonatal Intensive Care: A Controlled Study." Pediatrics. **81** (March 1988): 372-78.

Statistical Process Control Software Version 1.2, Departmnet of the Air Force, Maxwell Air Force Base, Alabama.

Subramanian, Chitra, Cherie Clark-Peakash, Larine K. Dadina, Bruce Ferrara, and Dana E. Johnson. "Intensive Care for High Risk Infants in Calcutta." American Journal of Disabled Children. **140** (September 1989): 885-88.

SurveyPRO Version 1.8, Apian Software, Menlo Park, California.

Svetz, Cynthia, Capt, USAF. Charge Nurse, Obstetric Service, USAF Academy Hospital. Interview by author, October 19, 1994, Fort Carson, Colorado.

Unger, Alice, Janet Weiser, Robert McCullough, Ann Keefer, and Lorna G. Moore. "Altitude, Low Birth Weight, and Infant Mortality in Colorado." Journal of the American Medical Association. **259** (June 1988): 3427-32.

Warner, Garry V., Staff Sergeant, USA. Ward Master, Newborn Nursery, Evans Army Community Hospital. Interview by author May 25, 1995, Fort Carson, Colorado.

World Health Organization's Collaborative Studies of Hypertensive Disorders in Pregnancy. "Geographic Variation in the Incidence of Hypertension in Pregnancy." American Journal of Obstetrics and Gynecology. **158** (January 1988): 80-3.

Yancey, Michael K., Jane Moore, Kim Brady, Douglas Milligan, and William Strampel. "The Effect of Altitude on Umbilical Cord Gases." Obstetrics and Gynecology. **79** (April 1992): 571-74.

Yancey, Michael K. and Douglas S. Richards. "Effect of Altitude on the Amniotic Fluid Index." Journal of Reproductive Medicine. **39** (February 1994): 101-104.

Zamudio, Stacy, Tarshi Droma, Kundu Y. Norkyel, Ganesh Acharya, Joseph Zamudio, Susan N. Niermeyer, and Lorna G. Moore. "Protection from Intrauterine Growth retardation in Tibetans at High Altitude." American Journal of Physical Anthropology. **91** (June 1993): 215-24.

Zamudio, Stacy, Susan K. Palmer, Thomas E. Drahms, Jonathan C. Berman, Roseann G. McCullough, Robert E. McCullough, and Lorna G. Moore. "Blood Volume Expansion, Preeclampsia, and Infant Birth Weight at High Altitude." Journal of Applied Physiology. **75** (Fall 1993): 1566-73.

Zupancic, J. "Dangerous Economics: Resource Allocation in the NICU." Canadian Medical Association Journal. **146** (1992): 1073-75.